Vol. 54 No. 4 April 1961

Quarterly

of the

National Fire Protection Association

INTERNATIONAL

Promoting the Science and Improving the Methods of Fire Prevention and Protection Since 1896

Instant protection

when and where it's needed

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Fires must be stopped at their source, *quickly*, before they have time to grow.

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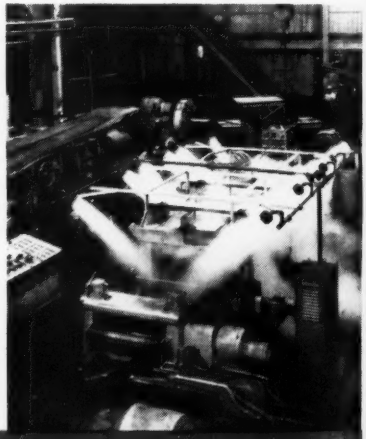
- Spray Painting Areas
- Welding Areas
- Greasing and Degreasing Areas
- Dryers and Ovens
- Conveyor Trenches
- Lacquering and Waxing Operations
- Heat Treating Equipment
- Computers and Electrical Equipment



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Vol. 54 No. 4 April 1961

Quarterly

The Standard Technical Journal of Fire Protection for More Than Fifty Years

The NFPA is a nonprofit technical and educational organization devoted to the reduction of loss of life and property by fire with a total membership of nearly 18,000. The QUARTERLY is one of the publications regularly provided to members. Other membership publications include *Fire News*, *Advance Reports* to the Annual Meeting, a *Year Book*, and many leaflets, pamphlets, and posters issued throughout the year on fire prevention and control. Seven volumes of the National Fire Codes are available on an annual subscription basis, one volume free and others at reduced membership rates. For full details on available material ask for a free list of "Publications on Fire Prevention and Protection."

NFPA annual dues are $15.00 for Associate Membership of which $6.00 is for subscription to this Journal. National and regional societies or associations may apply for an organization membership for which annual dues are $100; such a membership entitles four individuals to receive the periodical membership publications.

Technical committees of the Association develop means to safeguard life and property through the publication of standards covering all phases of fire prevention and protection. Your membership in the Association affords an opportunity to keep abreast of these developments, and, by being a member, you help support this humanitarian activity. Popular educational literature on fire safety is constantly being produced by the NFPA for distribution through its members to the general public.

National Fire Protection Association

International

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Quarterly

of the

NATIONAL FIRE PROTECTION ASSOCIATION

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Table of Contents

The Largest Industrial Fire Loss of 1960 ..... Frontispiece

Aircraft Carrier Constellation Fire
Asst. Chief J. T. Ward and Lieut. J. F. Casey, NYFD 283

What's in a Symbol? 292

Meeting of Board of Directors 293

Act II — The Indirect Losses 297

Large Loss Fires of 1960
Introduction 301
Building Fires — Spread of Fire 305
Building Fires — Private Fire Protection 327
Building Fires — Time, Place, and Origin 338
Building Fires — Detection of Fire 341
Building Fires — Alarm of Fire 349
Building Fires — Public Fire Protection 355
Building Fires — Conclusion 363
Building Fires — Table I — Factors Responsible 365
Fires Not in Buildings 369
Aircraft Fires 375
Table II — Listing by Occupancy 391

Rocket Experiment Safety
Atlantic Research Corp., Alexandria, Va. 406

U. S. Naval Deperming Station Fire 422

Fire Record of Cities 426

Index to Volume 54, NFPA QUARTERLY 437

Index to Advertisers 446

Articles and accounts of fires appearing in the Quarterly are based on material forwarded to the Association. The Association, as a body, does not assume responsibility for the accuracy of the material printed herein.

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Thomas J. Lynch

This $8,000,000 loss in Clifton, N. J., on February 17 was the largest industrial loss of 1960. The factors responsible for this and the other 390 fires in 1960 that each caused property damage of at least $250,000 are reported in the article Large Loss Fires of 1960, commencing on page 301.

Wide World

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Thomas J. Lynch

Aircraft Carrier Constellation Fire

By Asst. Chief J. T. Ward and Lieut. J. F. Casey

New York City Fire Department

EDITOR'S NOTE: The NFPA is indebted to Edward F. Cavanagh, Jr., Commissioner of the Fire Department, City of New York, for authorizing the preparation of this report for publication in the QUARTERLY. Chief Ward and Lieut. Casey have compiled a detailed and clear account of the operations of the New York Fire Department at this fire. A few details not related to actual fire department operations, for example, a discussion of the outbreak of the fire, have been added by the NFPA staff.

On December 19, 1960, fire broke out on the *U. S. S. Constellation*, an aircraft carrier nearing completion at the New York Naval Shipyard in Brooklyn. During the next 17 hours, 50 shipyard workers were fatally injured and 336 suffered nonfatal injuries. Forty firemen were injured during fire fighting and rescue operations. The Navy Department, on January 4, released a property damage estimate of $47,942,000.

Description of the Carrier

The *U. S. S. Constellation*, one of six Forrestal class aircraft carriers in service or under construction, was moored to a pier in the shipyard at the time of the fire. The ship is 1,047 feet long and 252 feet wide at the broadest part of the flight deck. When fully loaded the gross weight is 76,000 tons.

Conditions in the Ship

The construction of the hangar deck, where the fire originated, was such that it resembled a huge auditorium, several blocks long, that extended below the flight deck, almost from bow to stern, in one unbroken and undivided area. Because the ship was in its final stages

of fitting out, this deck contained large quantities of construction materials, paints, and tools that were stored in wooden sheds, in packing cases, or were exposed on the deck. Welding crews with their equipment, including cylinders of acetylene and oxygen, were located at various points throughout the hangar deck at the time of the fire.

A temporary platform of heavy wooden planking was suspended by tubular steel scaffolding 6 feet below the ceiling in the general area of the hangar deck where the fire originated. This arrangement created a 6-foot-deep concealed space, somewhat like that formed by a suspended combustible ceiling.

Between the hangar deck and the flight deck there was a gallery deck, and forward of the hangar deck and separated from it by a bulkhead were three decks whose total height equaled the height of the hangar deck. (See diagram on page 286.) The gallery deck and the three forward decks were honeycombed with small steel compartments and narrow steel passageways. At the time of the fire these decks were occupied by several hundred workmen. Conditions were similar on the decks below the hangar deck. More than 3,200 men were working in the ship when the fire occurred.

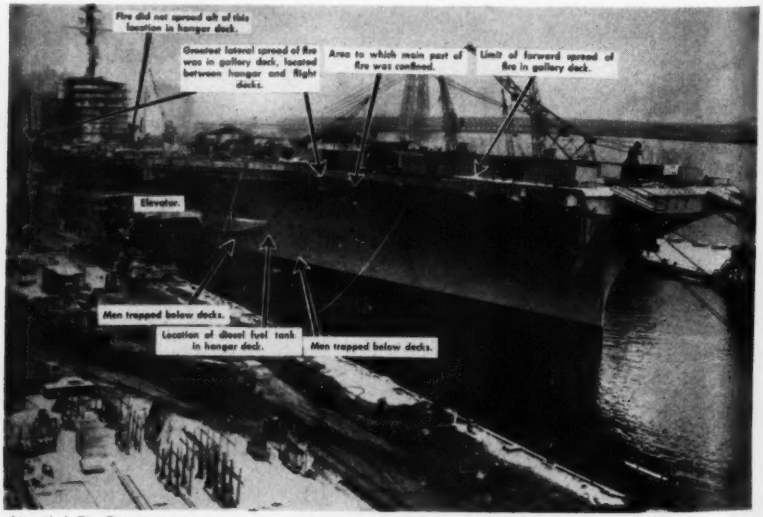
Access and Exits

Access to the ship was by means of two outboard aircraft elevators adjacent to each other forward of amidships. They were positioned at hangar deck level, starboard side (pier side), as shown in photo below. Stairs led down to the pier from each elevator.

Routes that workmen followed between the hangar deck and their assigned areas changed frequently to accommodate construction progress, thus preventing thorough familiarization with ways out of the ship. This factor may have been responsible for some of the casualties.

Fire Protection

When the vessel is completed, its fire protection is to include a manually operated deluge sprinkler system for the


Fire did not spread aft of this location in hangar deck.
Greatest lateral spread of fire was in gallery deck, located between hangar and flight decks.
Area to which main part of fire was confined.
Limit of forward spread of fire in gallery deck.
Elevator.
Men trapped below decks.
Location of diesel fuel tank in hangar deck.
Men trapped below decks.

New York Fire Department

hangar deck. This system was not in operation at the time of the fire; neither was a planned high-pressure standpipe and hose system to supply fog nozzles. There was in service, however, a standpipe and hose system equipped with straight stream nozzles. Portable fire extinguishers were distributed throughout the ship.

Water supplies for fire fighting purposes were practically unlimited. The Yard had its own hydrant system, supplied by city water mains, and consisting of standard and flush-type hydrants adequately spaced. In addition, facilities for drafting water from the East River were available throughout the Yard.

Finally, the vast resources of the New York City water supply system were available in city mains just outside the Yard wall. This latter source would require somewhat lengthy stretches, but, fortunately, its use was not required.

At the height of the fire, lines were simultaneously supplied by pumpers at hydrants, pumpers drafting water, and, from five fireboats, 3½-inch lines gated to supply numerous 2½-inch lines in all parts of the ship.

The Navy Yard Fire Department, consisting of two engine companies and a ladder company, was backed up by the New York City Fire Department.

The Outbreak of Fire

During the year preceding this disastrous fire there had been 42 fires aboard the carrier, all small and all put out with extinguishers before Navy Yard fire fighters arrived at the scene. The story of the 43d fire was different.

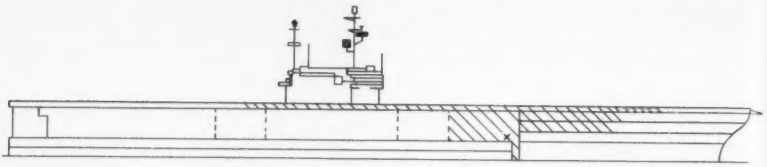
Shortly before 10:30 A.M., a forklift truck, in moving a large metal trash bin in the hangar deck, pushed the bin against a 1,800-pound steel plate resting on a pallet. The force of the blow rammed the plate against a valve in the bottom of a horizontal 1,200-gallon tank, knocking off the valve. The tank had been placed at the forward end of the hangar deck as a temporary diesel fuel supply (similar to kerosene) for auxiliary electric generating equipment. It contained about 500 gallons on December 19.

Wide World

When a valve was accidentally knocked from the bottom of this tank, 500 gallons of diesel fuel spilled on the hangar deck.

Because the vessel was trimmed at the stern, most of the oil escaping from the tank flowed aft through the hangar deck but some of it spilled down a bomb elevator shaft. Sensing the danger, workmen hurried to get two standpipe hoses in operation to wash away the spilled fuel and to attack the fire if one should break out. The Navy Yard's fire department was notified of the situation and word was passed via a public-address system on the hangar deck to stop all smoking and to shut off cutting and welding torches. It is doubtful if this message got to those working at other levels than the hangar deck. In the absence of fire no evacuation order was given.

The two hoses supplied by the ship's standpipe system had been brought into position for use when a burst of flame



Starboard elevation of *U.S.S. Constellation*, showing extent of fire. The diesel fuel tank, indicated by "X" was located on the hangar deck. Shaded area indicates extent of fire.

came up to the hangar deck from the bomb elevator shaft and ignited the oil flowing aft on the deck. Confronted suddenly with a large, intense fire, the men with the hoses had no choice but to retreat as did others who first opened the valves on several carbon dioxide extinguishers and tossed them into the fire. At about this time Navy Yard fire fighters are said to have arrived at the hangar deck with land-connected hose lines.

Fire Fighting and Rescue

Answering an alarm from a box in the Navy Yard at 10:30 A.M., city fire companies arrived shortly after the Navy Yard companies. Upon arrival, first alarm units of the New York Fire Department were informed of the fire's location by naval authorities and were also told that more than 3,200 workmen were on board ship when the fire broke out. Hundreds were trapped, some on the decks immediately below the hangar deck, others in the three forward decks, and still others in the gallery deck.

City Fire Department Response

After the first alarm was received at 10:30, additional alarms were sounded. Within half an hour a fifth alarm had been ordered. By 2:30 P.M. an additional fifth alarm assignment was at the fire. This assignment brought all engine companies to the Navy Yard that would have responded to a fifth alarm at Box 277 in Manhattan, across the Williamsburg bridge from the Brooklyn Navy Yard. With special calls, these signals brought to the fire 35 engine companies, 5 ladder companies, 6 squad companies, 4 rescue companies, 4 marine companies (fireboats), and 10 special units.

Command Headquarters

Near the foot of the stairs that led down from the elevators to the pier, a pierside Command Headquarters was established using the facilities of the Field Communications Unit. Here, liaison was maintained between Fire Commissioner Cavanagh, Chief of Department David, Admiral Pyne and other Navy Yard personnel, and various other agencies such as police, health, water, and hospital departments, public utilities, chaplains, Red Cross, Salvation Army, and press, radio, and television reporters.

Requests for assistance, reports of problems encountered, fire travel, and rescue and progress reports were received at Command Headquarters. Field orders were issued here, providing an organized rescue and fire fighting operation and coordinating the operations of hundreds of fire department, naval and volunteer personnel.

Medical aid, including inhalators and resuscitators, chaplains, naval specialists, construction engineers, welders, burners, and other specialists were dispatched from this Command Headquarters, as were masks and other equipment.

This was also the point at which incoming units reported and were dispatched to critical points on the ship.

Hangar Deck Fire

The spreading, flaming oil had carried the fire to combustible construction materials, and when first alarm units reached the hangar deck they were confronted with a tremendous blaze approximately 120 feet wide, 300 feet long, and 50 feet high. The fire was being fanned by 8- to 12-miles-per-hour winds blowing into the hangar deck through the huge aircraft elevator shaft openings on the starboard side.

The initial attack on the fire was made with hand lines that were stretched up the stairs that led from the pier to the elevators and thence into the hangar deck where the fire raged. As more lines were run from the pier to the hangar deck, a heavy concentration of powerful streams was operated into the tremendous volume of flame that had cut off the escape route for hundreds of workmen trapped in the gallery deck, in the three decks forward of the hangar deck, and in the decks below the hangar deck.

Lines were directed overhead and forward in ovenlike temperatures, with the water from these lines often being converted to steam immediately upon striking the red hot metal plates of the ship. The attack was complicated by the wooden plank scaffolding that was hung 6 feet below the ceiling of the hangar deck by metal hangers. This scaffold not only provided a concealed

Wide World

View of hangar deck looking forward. The wooden plank scaffolding suspended 6 feet below the ceiling may be seen. Fire above the scaffolding was difficult to reach with hose streams. Falling sections endangered fire fighters.

space for the fire to spread, but as the fire progressed, sections of the scaffold failed and fell, endangering the lives of the fire fighters. As additional companies arrived, hose lines were stretched from the pier to the hangar deck to reinforce the original attack positions and all units began to advance forward. Portable monitor nozzles, fed by siamesed lines at high pressure, now delivered effective streams capable of covering the extreme height and area burning within the hangar deck. These portable monitors were equipped with 1¼-inch nozzles of the straight-stream type and operated at approximately 80-pounds-per-square-inch nozzle pressure.

Gallery Deck Fire

As the fire spread fore and aft in the hangar deck, it also extended to the heavily compartmented gallery deck overhead, primarily because of heat radiated and conducted by steel deck plates that had been made red hot by the fire in the hangar deck.

The gallery deck fire was attacked from the flight deck and from the hangar deck. From the flight deck, distributor nozzles were operated through existing openings located directly over the fire and through openings cut in the deck with torches at locations where flight deck plates were buckling. As soon as large caliber distributor nozzles were lowered into these openings, jets of steam spewed forth. However, continued operation of the distributors slowly lowered the high temperatures in the areas where they were used. The distributor nozzles were also credited with checking the fore and aft extensions of the fire in the gallery deck.

Hand lines were advanced up a wooden stairway leading from the hangar deck forward of amidships, and attempts were made to enter the gallery deck. Heat and fire conditions were intense. As soon as streams contacted red hot metal they were converted into scalding steam, driving extreme heat down on the advancing men. Slow penetration of the gallery deck by fire fighters using hand hose lines finally completed extinguishment in this area.

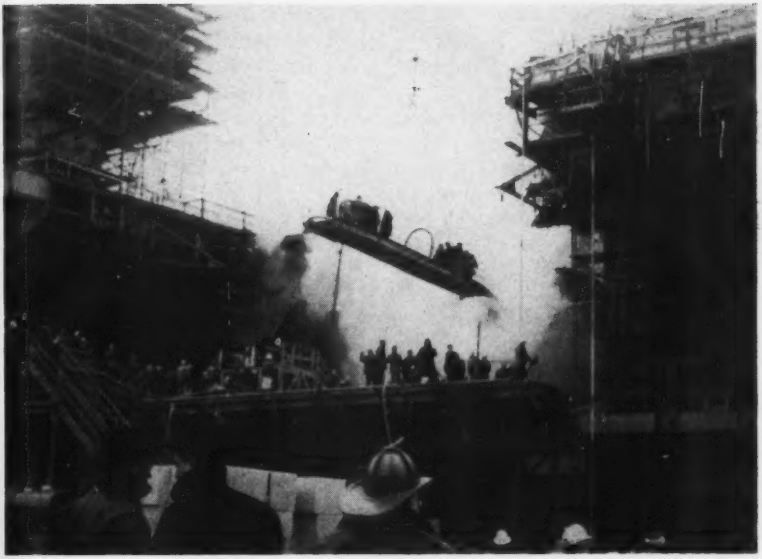
Rescues were effected and victims removed in a slow, grueling advance through ovenlike passageways which led to a myriad of compartments that were to be used for crews' quarters, storage, etc.

Flight Deck Fire

As fire raged in the hangar deck and gallery deck it also spread to combustible material on the flight deck, partly because of radiation and conduction of heat from the flight deck plates and partly because of an opening that extended from the hangar deck up through

Wide World

Stern view of *U.S.S. Constellation*. Several 3½-inch lines were pulled from fireboats up to the flight deck where they were gated to 2½-inch lines for use on flight deck fires.



Wide World

A cargo platform maneuvered by a crane was used to remove workers trapped on the flight deck and to hoist fire fighters and equipment aboard.

the gallery deck to the flight deck. There was a wooden stairway in this vertical opening.

By the time a strong attack could be made on the fires on the flight deck, flames 20 feet high were bursting from the vertical opening and had ignited a wooden shed, containing hundreds of gallons of paint, that had been erected on the flight deck adjacent to the opening. Utility openings in the deck were discharging large volumes of intense heat and dense black irritating smoke and fumes. Breathing was difficult and vision was seriously impaired.

The 2¼-inch steel plates on the flight deck were buckling from the intense heat generated below, and a continuous line of construction sheds located on the port side of the flight deck had been ignited by the hot deck plates. Gasoline-powered construction vehicles on the flight deck and wood enclosures over catapults were threatened with momentary ignition.

Several 3½-inch lines were pulled up to the flight deck from fireboats and gated to 2½-inch lines. These were used to extinguish fire in structures on the flight deck, to cool surfaces of the flight deck and thereby prevent ignition of hose lines, and to prevent reignition of wood structures.

Admiral Pyne had requested Commissioner Cavanagh to make every effort to stop the fire before it reached the multistoried "island" on the starboard side of the vessel extending above the flight deck level, since it contained electronic equipment worth millions of dollars. As additional New York City Fire Department companies arrived, other lines were advanced from the pier to the flight deck, forward and aft, by way of aerial ladders. Augmented by these lines, fire fighters on the flight deck prevented involvement of the "island."

The men on the flight deck when the fire broke out, or who had managed to reach it before passageways became impassable, got off the ship in various ways. Some jumped into the water, others slid down ropes to a barge tied to the port side, others were taken down aerial ladders raised to the flight deck from ladder trucks parked on the pier, and still others were carried to safety by a cargo platform maneuvered by a crane operator.

Fire in the Forward Decks

Heat radiated and conducted by steel bulkhead plates caused fire to break out in the upper two of the three decks forward of the hangar deck. After the fire in the hangar deck had been darkened down, holes were cut in the bulkhead to relieve the forward decks of pent-up heat and smoke. Wearing breathing masks and working in complete darkness, fire fighters advanced lines forward through port and starboard passageways and thence into the compartmented forward decks. The workmen who were trapped in compartments were completely cut off from escape by the fire in the hangar deck, and it was in this forward area that the largest number of casualties occurred. However, many were taken out through portholes, hawser openings, and through holes cut in the ship's plates by torches. These rescues were effected by use of fully extended aerial ladders, by aerial ladders with portable ladders used as horizontal scaffolding between the aerial and port hole, by derricks, cranes and roof ropes.

A multitude of hand lines, manned by the mask-equipped men who had to be constantly relieved, finally reduced temperatures sufficiently to permit the entire area to be searched and victims removed. Many workmen forward of the hangar deck had literally sealed themselves in compartments to escape the smoke and heat and then called for help by banging with tools on metal plates, bulkheads, etc. Firemen in their search had to pause to listen for and then attempt to trace the sounds. At the same time hose lines had to be advanced and operated.

Masks were a must for any man operating below decks. Fire department units responding to the scene carried 220 self-contained masks and a total of 640 cylinders, all of which were used and re-used.

The Department's Mask Maintenance Unit set up a shuttle service from the scene of the fire to the "air banks" at the Division of Training in Long Island City, more than four miles away.

At the same time several "cylinder depots" were established throughout the ship to facilitate and expedite the change-over from used cylinders to fresh cylinders for the firemen, who were constantly being relieved within the twenty-minute average time limit established by the Department for self-contained masks.

Below the Hangar Deck

Although the fire below the hangar deck level was confined primarily to the bomb elevator shaft, many workmen were trapped in lower levels since normal routes out were up and through the hangar deck.

A passageway on each side of the hangar deck gave access via stairs to the decks below the hangar deck. These passageways were heavily charged with heat and smoke, and were in total darkness from the beginning of the fire, when the power had been shut off. Masked men had to negotiate these passageways to get down to the trapped workmen, an exhausting process that saw some of the rescuers being carried out along with the rescued.

Fire Fighting Summarized

The problem of rescue was probably the most difficult ever encountered by the New York City Fire Department. No accurate count of the men carried or assisted from the ship was kept, but it ran well into the hundreds.

This fire was also one of the biggest fire control jobs ever tackled by the Department, as the following statistical résumé of response and operations will attest:

Total Response of Fire Fighting Units

Engine Companies	35
Ladder Companies	5
Marine Companies	4
Squad Companies	6
Rescue Companies	4
Searchlight Units	3
Ambulance Units	2
Total:	59

Total Response of Officers and Firemen

Chief of Department	1
Assistant Chiefs	5
Deputy Asst. Chiefs	6
Deputy Chiefs	3
Battalion Chiefs	3
Medical Officers	8
Company Officers	61
Firemen	493
Total:	580

Operations of Engine and Marine Companies

Hose lines of 3 ½-inch hose	10
Hose lines of 3-inch hose	13
Hose lines of 2 ½-inch hose	42
Total:	65

Number of open nozzles	7
Number of controlling nozzles	44
Number of distributors	12
Number of cellar pipes	2
Total:	65

NOTE: Hose lines operating on hangar, gallery and below decks were constantly being moved from one position to another. All members of Engine and Marine Companies were used for search and removal operations.

Ladder, Rescue, and Squad Company Operations

Aerial ladders raised to flight deck for removal of workers and access by fire fighting members.

Mask operations for search and removal of workers from all decks and compartments.

First aid to injured.

Cutting with oxyacetylene torches.

Searchlight Units Operations

Placed stationary and portable floodlights in various exterior and interior positions as directed by Officers in Charge of Operations.

Ambulance Units Operations

Eight Medical Officers administered first aid to injured civilian and uniformed personnel. Injured members removed to hospitals.

What's in a Symbol?

Sparky was "born" several years ago in an effort to cut down the increasing number of home fires — and particularly the appalling fire death rate among children.

Of what value is a symbol such as Sparky to a basically technical organization such as NFPA?

Technical data, to have social meaning, must be translated by people into action and people seem to need visible reminders of invisible ideas if these ideas are to be kept alive and constantly in motion. This is one reason.

A second is that a symbol can express much more meaning than mere words.

Take the national flag, for instance. What words could possibly be substituted — whether emblazoned in huge letters, cried over the loudspeaker, or even sung — for the majesty, dignity, hope, brotherhood, freedom, unity, history, opportunity, victory, and sacrifice represented by that simple fragment of color and cloth breeze-blown against a blue sky?

Another reason for employing a symbol to tell a story is that a symbol means as many things as there are people to look at it, because each one attaches to it all the experience he has had with the subject symbolized. While a fireman may look at Sparky and recall fires that have wiped out whole families, a youngster may look at the same Sparky and picture a heaping plate of ice cream served up at the fire station — if that's his only connection with Sparky to date.

A symbol therefore is an invaluable teaching tool because it continues to take on new meaning as experience and knowledge are multiplied.

Still another reason for using a symbol is its appeal to all ages. While words must be either very general and therefore rather meaningless, or else limited specifically to particular age groups, the symbol is meaningful to everyone because each one interprets it in his own thought context. Allied to this reason is, of course, the fact that the symbol knows no language barrier.

Lastly, a symbol can help individuals or individual groups to identify themselves with larger purposes, higher aims, and wider usefulness in the fight for universal welfare.

Sparky, the Fire Dog

Sparky, the Fire Dog, the NFPA symbol of home and personal fire safety, has been developed for all these reasons.

In the adult mind the Sparky symbol may bring to thought the whole important program of educating young and old in one of the most basic areas of human experience — fire.

For children, Sparky probably represents the courage and daring of the fireman and means an opportunity to explore and learn about the fascinating world of fire as well as signifying that they have some share in an area of adult responsibility.

To both adult and child the Sparky symbol is a point of identification with the universal urge to do something for the betterment of mankind.

The countless ways in which Sparky is being used attest to the versatility of the symbol as well as to the intelligence and imagination of the many public-spirited citizens who are putting it to work.

Meeting of Board of Directors

Union League Club, New York, January 19, 1961

Members Present

T. Seddon Duke, Chairman
Loren S. Bush, President
J. Sharp Queener, Vice President
Warren J. Baker, Vice President
John A. Neale, Past President
Henry G. Thomas, Past President
Hovey T. Freeman, Secretary-Treasurer

W. H. Berry
A. Sidney Briggs
J. R. DeHaven
Frank J. Fee, Jr.
R. H. Ferguson
W. H. Forristall
Paul C. Lamb
Elmer O. Mattocks
William L. Miller
John H. Redmond
Carroll E. Shaw
W. M. Wetzel
E. C. Wood

Merwin Brandon, Chairman, Electrical Section, was present as a guest by invitation.

Percy Bugbee, General Manager; Robert S. Moulton, Technical Secretary; Horatio Bond, Chief Engineer; Charles S. Morgan, Assistant General Manager; George H. Tryon, Assistant Technical Secretary.

Business Transacted

1. Mr. Bugbee reported on the 1961 annual meeting, scheduled for the Hilton Hotel, Detroit, May 15–19, 1961, outlining plans and soliciting suggestions from members of the Board. He also reported on the Philadelphia meeting scheduled for the Sheraton Hotel, May 21–25, 1962.

Mr. Bugbee reported difficulties in the original plans for meeting in San Francisco in 1963 and suggested for consideration Portland, Oregon, May 20–24, 1963. This plan was tentatively approved and Mr. Bugbee was authorized to proceed with tentative hotel commitments.

Tentative plans for a meeting in Dallas, Texas, May 18–22, 1964, and in Washington, D. C., May 17–21, 1965, were approved.

2. Treasurer Hovey T. Freeman reported on NFPA financial affairs indicating that current operations were in the black but that the margin of income over expenditures was small.

Executive Office Activity

3a. Mr. Bugbee reported on the NFPA membership campaign, indicating a total of 18,333 members as of the first week in January, including 206 organization members, the total membership including representation in 55 countries. He outlined the active work now going on in membership promotion and expressed appreciation to Past President John A. Neale for his assumption of the chairmanship of the Membership Committee to take the place of the late H. E. C. Rainey.

b. Mr. Bugbee reported on the Finance Campaign Sponsors Committee, explaining its history and functions and commending the cooperation of the present Chairman, Mr. Charles Francis Adams, Chairman of the Board of the Raytheon Company.

c. Mr. Morgan reported on advertising indicating a substantial increase in advertising revenue, developed by Mr. Gere, Advertising Manager.

d. Mr. Bugbee reported on the activities of the Public Relations Department, commenting upon the results of the current Fire Prevention Contest con-

ducted by this department and commended the activities of Mr. Richardson, its Manager.

e. Mr. Bond presented a report for the Fire Service Department explaining its many activities and commending the services of Mr. Kimball and his associate, Mr. Lyons.

f. Mr. Moulton reported on the NFPA Fire Record Department under the direction of Mr. Babcock, with the assistance of Messrs. Wilson and Torrey, and presented a report of their widespread activities in the field of fire record.

g. Mr. Brandon reported on electrical field service indicating general satisfaction with the activities of the NFPA Electrical Field Engineer, Mr. Stetka.

h. Mr. Mattocks reported on the activities of the flammable liquids field service, conducted by Mr. Miles E. Woodworth, which provides an increasingly valuable service to all those interested in this field.

i. Mr. Baker reported on the gases field service reporting equal satisfaction with the work of Mr. Clark F. Jones.

j. Mr. Tryon reported on progress in the work of development of the Handbook of Fire Protection, explaining the magnitude of the work, the degree of cooperation received from members of the Handbook Committee and various consultants, and expressed the hope that the book would be completed during the year 1961.

k. Mr. Tryon reported on the Publications Department, indicating a total of some eleven million pieces of printed matter distributed by the NFPA during the year and the fact that the Publications Services Department had almost 50,000 individual requests for publications during the year.

Reports of NFPA Sections

4a. Mr. Morgan reported on the Fire Marshals Association of North America explaining that this is our oldest section and has great vitality and usefulness.

b. Mr. Brandon, Chairman of the Electrical Section, reported on its activities and made recommendations concerning the personnel of the Electrical Correlating Committee. Mr. Brandon presented his resignation as Chairman of the Electrical Correlating Committee and the National Electrical Code Committee. This was accepted with expresions of appreciation for Mr. Brandon's fine service. (Mr. Brandon will remain as Chairman of the Electrical Field Service Committee which has responsibility for direction of the electrical field service project.) Mr. Louis LeFehr, Chief Electrical Inspector of Alhambra, Calif., was appointed as a member of the Electrical Correlating Committee. Mr. Gaffney and his alternate, Mr. Cannady, were relieved of further responsibilities on the Electrical Correlating Committee.

c. Mr. Baker, Vice President of the Society of Fire Protection Engineers, reported on the affairs of the Society, indicating a continuing healthy growth.

Fall Conferences

5. Mr. Bugbee reported on the NFPA Fall Conference held in Columbus, Ohio, on November 14–16. President Bush and others commented favorably on the excellent attendance at this conference and the degree of interest shown.

Mr. Bugbee reported plans to hold the 1961 Fall Conference in Kansas City, Mo., on October 30–November 1. These plans were approved.

Mr. Bugbee reported postponement of the idea of having a Fall Conference in London, England, pending opportunity for further exploration of the possibilities.

Rural Field Service Project

6. Mr. Bugbee reported on the proposed rural field service project which has been previously approved by the Board but has been deferred because of lack of sufficient financing. The project has received the support of the National Association of Mutual Insurance Companies and some $8,000 has been pledged by various members of that Association. It was agreed, however, that this sum was not sufficient to justify inauguration of the project and its inception was deferred pending receipt of assurances of the availability of adequate financial support.

Relations with ASA and NSC

7. Mr. Mattocks reported on relations between the NFPA and the American Standards Association, stating that certain procedural questions which had handicapped cooperation on the part of the NFPA had been referred to the American Standards Association for attention.

8. Mr. Bugbee reported on relations with the National Safety Council, explaining a number of recent cases where National Safety Council activities in his opinion had been contrary to the best interests of fire safety. This matter was discussed by Messrs. Mattocks, Queener, Freeman, Shaw, and Ferguson, and the hope expressed that the National Safety Council might more effectively correlate its activities with those of the NFPA in the matter of fire safety.

Other Projects

9. A proposal by the Electrical Correlating Committee that membership certificates be issued to members of Code-Making Panels of the National Electrical Code Committee was discussed without action. It was agreed that such certificates would be desirable, but it was felt that they should be issued to all members of all NFPA committees and that this detail would place an excessive burden on the NFPA office.

10. Mr. Baker presented a proposal of the Executive Committee of the Society of Fire Protection Engineers for the establishment of life membership in the Society for members of 65 years or over who have held membership for ten or more consecutive years on a lump sum payment of $25. The Board saw no objection to this proposal, provided that membership in the NFPA is continued. (This requires action by the meeting of the Society in May 1961 before it can be put into effect.)

Technical Advisory Committee Report

11. Mr. Duke, Chairman, presented the report of the Technical Advisory Committee which was accepted and the following actions taken:

It was voted to confirm the various committee appointments incorporated in the 1960–61 Year Book which were made by the Technical Advisory Committee in accordance with authorization of the Board at its last meeting. It was also voted to confirm the committee appointments submitted to the Board with the agenda and supplementary appointments (list published in the February *Fire News*).

It was voted to create a new Committee on Boiler-Furnace Explosions with the following scope statement:

> The prevention of explosions of pulverized, liquid, and gaseous fuels separately or in combination in industrial and public utility boiler-furnaces, of types designed to produce 10,000 or more pounds of steam per hour. Topics included are manual, semi-automatic, and automatic systems, dealing with matters such as combustion controls, combustion safeguards, and ventilation.

The Technical Advisory Committee was authorized to proceed with the formation of this committee, including appropriate representation from other

committees now dealing with Standards on Pulverized Fuel, Gas, and Oil Burning Equipment, in order to maintain proper correlation.

It was voted to create a new type of committee membership to be known as "Corresponding Member," this type of membership to be limited to residents of countries other than the United States and Canada who will be in a position to maintain contact with their committees by correspondence. They will be nonvoting members. It was also voted to confine the term "Liaison Member" to nonvoting representation of manufacturers and others as typified by the present membership of the Committee on Aviation and that intercommittee representation would be designated as such rather than as "Liaison."

No action was taken on the recommendation concerning type of sponsorship of standards on Dust Explosion Hazards pending the outcome of the consideration covered in Minute No. 7.

A proposal for a deletion of part of the Regulations Governing Technical Committees was discussed and referred back to the Technical Advisory Committee for clarification.

Building Materials Committee

12. Mr. Shaw, Chairman of the Committee on Building Materials, reported on a meeting of that committee held on January 16. Mr. Shaw's resignation as Chairman of the committee was accepted. Mr. Shaw also presented resolutions adopted by the committee at its meeting having to do with its own organization, responsibilities, and representation on the Committee on Safety to Life. These resolutions were referred to the Technical Advisory Committee.

Legal Liability on Standards

13. Mr. Morgan presented an opinion from the NFPA legal counsel indicating that neither the Association nor the personnel of technical committees have liability arising from their actions in the development and promulgation of standards. This was discussed by the Board and it was voted to distribute this opinion to members of the Board and chairmen of committees.

Committee Meetings

14. Mr. Moulton reported on the extensive technical activities of the Association and the 85 meetings scheduled for New York during a three-week period.

15. Mr. Bond, Chairman of the NFPA Committee on Research, reported on developments in this field and indicated that some form of NFPA staff agency will soon be needed to handle research matters. He observed that NFPA interests would be best served if the matter of this staff agency were left to the General Manager so that activities in this field would be subject to review and approval by the NFPA Board of Directors. He said that if research is handled under a program subject to direction by the NFPA Board it would be considered by many to be an ideal arrangement.

Act II — The Indirect Losses

The Narragansett Marine Laboratory Fire

EDITOR'S NOTE: On the cold, windy night of January 6, 1959, a fire, caused by improper electrical wiring, originated in the Narragansett Marine Laboratory of the University of Rhode Island, Narragansett, Rhode Island. The Laboratory was housed in an old, stone, wood-joisted building, formerly an inn, and lacked any form of automatic protection or even watchman service. Absence of a water supply for fire fighting eliminated whatever chance volunteer firemen might have had of saving the structure and its valuable contents once the fire was discovered. The building was a total loss.

The building was a total loss.

That's where most fire stories end — the last act, so to speak.

But almost every fire has a second act, rarely reported, rarely considered in prefire planning. The last flicker of a dying ember is the signal for the curtain to rise again. The cast of characters is the same. They have been on stage all night, reacting with horror and stunned incredulity.

When the roof caved in they knew it was all over. Dr. Pratt, and all the others who worked in the Laboratory, saw disappear in the roar of flames the fruits of years of patient probing into the secrets of the sea.

Lost Research Data

But the true scientist never completely gives up, and the next morning Dr. Pratt put on his old clothes and told his wife he was going over to the Lab to see if he could find a file or two still intact.

He assumed that the fire would have been out several hours.

What he saw was a great pit of glowing coals.

As he stared into the face of this unnatural furnace on that cold, gray day, the awful realization of what was lost began to take shape in his consciousness. No longer did he feel the blind fury of the night before when he almost rushed into the burning building to try to rescue his brand-new microscope. Now his disciplined, reasoning mind, developed through years of patient scientific study, mercifully began assessing the loss in terms of relative value.

"From the five years' accumulation of notes and data on my present project, not a scrap of paper remains," he thought. "Some of the material is summarized, yes. Two manuscripts are in the hands of scientific journal editors, but I will have nothing to compare next year's, or next month's results with! When someone writes me to know more about a particular phase of the work described in one of the papers, what research data will I have to send him? Nothing."

He knew his first job, therefore, must be to resume his main project, the study of marine life in Narragansett Bay.

This report is based primarily on information provided by Dr. David Pratt, a member of the staff of the University of Rhode Island's Graduate School of Oceanography (known as the Narragansett Marine Laboratory at the time of the fire). Dr. Pratt's recollections are principally of the intangible but very real losses he himself suffered. They could undoubtedly be duplicated by all of his teaching and research associates.

State Fire Marshal Bureau

Deterioration of overloaded and poorly grounded armored cable was the probable cause of fire that destroyed the 167-year-old stone, wood-joisted laboratory. The building and its equipment have been replaced. Research data, scientific libraries and other priceless papers are gone forever.

It took some doing — borrowing equipment from other labs and ingeniously adapting it to his highly specialized need, for instance — but his data collecting routine was back in operation in three weeks after the fire.

Lecture Notes

The fire occurred just a week before the term ended. The last few classes, Dr. Pratt taught without notes. He had lost all his lecture notes plus all the notes he had taken himself in over twenty years of study. Nothing left now but what relatively little he could remember. A couple of hundred references, maybe. A huge assortment of facts, formulae, and tantalizing half-remembrances.

Personal Scientific Libraries

Everyone — the seven research scientists, including the Laboratory's director and his wife (who is a researcher in her own right) and five graduate students — all lost personal scientific libraries. One student had books valued at $1,000. His representative in the Rhode Island Legislature filed a bill to reimburse him and he got the money, but the others were not as fortunate. Insurance helped some. Money, however, could never buy the files of reprints and tear sheets selected and collected over the years from scientific journals of all types. Dr. Pratt estimated his loss at some 700 reprints. He would not even be able to list them, let alone replace them.

Research Projects

All the graduate students in the department had class notes and research projects housed in the Laboratory. One project had to be abandoned altogether and the term ended for these students

with no examinations. How could they be examined with no notes to study from?

Doctoral Thesis

Mr. Napora was a student from New York City. On January 10, 1959, he had an appointment at Yale University to turn in his completed doctor's thesis. He was just relaxing for a few days after the terrible push to get it finished, hardly able to believe that it was finally all down on paper — the tables, graphs, summaries, statistics, and narration. All so neat-and-easy-looking now, but representing months of work off Bermuda and years of preparation before that.

He got down to the Laboratory shortly after Dr. Pratt did in the still dark hours of the fateful morning. The sky was aglow for miles around in the frigid air. The lab was just a furnace! *White* heat! The awful thought came . . . "My thesis! If only I could get in there . . . or maybe one of these fire fighters . . . no, it's too late." Then, the second thought, where were his notes? Were they in the other lab building?

Mr. Napora found his notes. He had taken them over to a different lab for some other work he was doing. He started soon to rewrite his thesis, to think, to write, to type . . . He is still at it two years later. He is almost fin-

State Fire Marshal Bureau

Most research papers were stored in ordinary metal filing cabinets. All were lost. Papers pertaining to research projects for the U. S. Navy which were required to be kept in two Class D insulated files were also lost. (Class D insulated files can withstand a standardized fire for at least one hour.) These files fell to the cellar where they remained among red hot debris for many hours. When they were finally hoisted from the cellar and opened, the insides were red hot.

ished, but not quite. Meantime, two years have gone by during which he has not been drawing an assistant professor's salary because he still does not have a PhD.

The Permanent Library

Aside from these personal losses — all of which were traumatic — the Laboratory itself lost precious treasure. Former scientists had left volumes of unexplored data. Laboratory equipment alone was valued at $43,750. All administrative records, such as the students' records and the financial status of the projects under way, were gone forever. The Laboratory's permanent library of marine biology books, many of which have been out of print for years, and complete sets of scientific journals, some dating back into the 1890's, had been reduced to ashes. (It is heartwarming to know that other libraries and individuals all over the country have been flooding the Laboratory with such replacements as are available.) The Laboratory also lost its complete card file index of oceanographic literature on the Pacific and Atlantic oceans. Salaries paid over the years for the compilation of this index totalled $60,000.

Inconveniences and Added Costs

The University also suffered. January 6, 1959, was the very day on which an officer of the college was to go to Providence to sign the contract for the new building that was to provide expansion facilities for the existing Laboratory. Construction on the additional space would have started immediately. Instead, the college representative did not go to Providence that morning; the plans had to be scrapped and new ones drawn up for a building adequate now to accommodate the entire staff of the Laboratory.

The loss to the taxpayer in the State of Rhode Island was not inconsiderable. The new contract was awarded to the construction firm with whom the old contract had been negotiated *without further bidding*, and the builder proceeded to cut lumber at his shop. Then the ugly head of politics reared up and forced the University to cancel the contract and open up the project for bids. But by that time the original firm's agreement was public knowledge so all new bids were lower and the first concern lost the contract. Naturally they sued the State for breach of contract and the State had to pay. Finally, in September, 1959, nine months after the fire, work on the new building was started. It was ready for occupancy only in July, 1960.

During the intervening nineteen long months — more than a year and a half — the students and staff worked in borrowed and shared quarters, crowded and cramped. In spite of that, many of the staff felt fortunate that the University chose to keep them on, notwithstanding the fact that it would be sometime before their productivity could be fully resumed.

This story could be told and retold hundreds of times, substituting only names, places, circumstances, and dates. Such are the inevitable indirect losses from unnecessary fires.

Large Loss Fires of 1960

A Special Report for NFPA Members

By the NFPA Fire Record Department

This study highlights the architectural, engineering, and fire protection failures responsible for the largest fires of 1960. Here are the results of the planning that was never done, the designs that were incomplete, and the equipment that was poorly maintained. Few fields of endeavor are fortunate enough to have their errors so clearly available for review, study, and correction.

Statistical Summary

During 1960 there were 391 fires and explosions in the United States and Canada causing losses of at least $250,000 property damage each. Of these, 66 involved losses of $1,000,000 or more. The total loss resulting from the 391 fires was the largest in history, $356,569,500, yet the number of large loss fires in 1960 was 39 less than the record 430 for 1956 and 19 less than the 410 for last year. Ten years ago the 1950 large loss story reported a total of 243 fires and a loss of $152,593,000.

These 391 large loss fires caused 209 deaths (including 79 aircraft fire fatalities) and 1,174 nonfatal injuries (aircraft injuries not included). This is a rise after a steady 5-year drop of the large loss fire-death total (401, 312, 263, 198, 209).

The $356,569,500 loss included $168,988,000 lost in the 319 building fires, $140,309,500 lost in the 39 transportation fires, $40,750,500 lost in the 24 forest fires, and $6,521,500 lost in the 9 miscellaneous fires.

The 391 large losses represented less than two hundredths of one per cent (0.02 per cent) of the total number of fires last year but caused approximately 23 per cent of the total dollar loss. Because of the effect of the few large loss fires on the annual total fire waste and also because of the many inevitable indirect losses resulting from such fires that cannot be measured in dollars, the large loss fires have been carefully analyzed each year by the Fire Record Department of the NFPA and the results published in the QUARTERLY.

Definition of "Large Loss"

A total direct fire loss to buildings, stock, machinery, and other tangible assets of over $250,000 is defined as a "large loss" for the purpose of this analysis. The total direct loss is the sum of the insured and uninsured direct losses.

Every large loss fire involves serious indirect losses. Most of these losses, however, cannot be readily measured. Business interruption, rental, and other insured indirect losses, where known, are shown in Table II, page 391. The total insured indirect loss reported this year is $13,943,000, an 83.5 per cent increase over 1959. This figure now equals 8.0 per cent of the building property damage loss as compared with 4.4 per cent a year ago.

Table A

Number of Large Loss Fires by Occupancies, 1956-1960

	1960	1959	1958	1957	1956	Average Number per Year
Total	391	410	356	422	430	402
Total Building Fires	319	331	286	327	320	317
Public Assembly	37	36	27	30	30	
Educational	16	18	17	19	21	
Institutional	4	2	1	0	3	
Residential	19	15	10	17	21	
Mercantile	59	79	77	51	48	
Office	2	5	2	8	5	
Industrial	128	115	89	126	125	
Storage	48	60	60	68	62	
Miscellaneous	6	1	3	8	5	
Total Fires not in Buildings	72	79	70	95	110	85
Transportation	39	47	55	66	92	
Forest	24	23	9	16	9	
Other	9	9	6	13	9	

Though every effort has been made to determine the actual loss in each case, the loss figures given should be considered approximate rather than actual.

Geographical Distribution

The United States was the location of 342 of the 1960 large loss fires. These fires caused a total of $324,898,500. Canada's toll was 49 fires causing $31,671,000 loss.

Two hundred and seventy-five of the 319 large loss building fires occurred in the United States, 44 in Canada. States with the greatest numbers were New York with 33, New Jersey 24, California 18, Pennsylvania 17, Ohio 16, Illinois 14, Michigan 11, Indiana and Massachusetts 10 each. In Canada, the Province of Ontario had 13 large loss building fires, Quebec 9, and British Columbia 8.

Occupancy Distribution

Table A shows the number of large loss fires in the years 1956–1960 by occupancy classification. The number in 1960 was the second lowest since 1956 which experienced 316 large loss fires.

The table below shows the nine specific occupancies that were most often burned in the 1960 large loss fires.

The Nine 1960 "Most-Burned" Occupancies

	Number	*Per Cent*
Public Schools	13	4.1
Steel Fabricating	12	3.8
Hotels	11	3.4
Supermarkets	11	3.4
Churches	9	2.8
Saw and Planing Mills	9	2.8
Restaurants	8	2.5
Shopping Centers	8	2.5
Department Stores	7	2.2
Total	88	27.5

The two significant 1960 decreases were the 25 per cent drop in large loss mercantile fires — a reversal of the previous five-year continuous rise — and the 20 per cent drop in large loss storage fires. The major increase was the 11 per cent rise in industrial large loss fires to a new all time high of 128 fires.

Cause of Fires

There were approximately 900,000 building fires in the U. S. and Canada in 1960. Each of these fires was caused by something or someone, but only 430 became large losses.

Table B

Principal Large Loss Building Fire Causes by Number of Fires

Cause	1960	1959	1958	1957-1953
Electrical Fires	49	58	54	112
Fixed services, fires due to misuse, or faulty wiring, equipment	36	45	41	77
Power consuming appliance failure	13	13	13	35
Incendiary, Suspicious	28	28	24	67
Smoking and Matches	21	21	15	33
Heating and Cooking	17	26	27	64
Oil fired equipment defective or overheated	6	5	10	11
Gas fired equipment defective or overheated	4	9	3	3
Other equipment defective or overheated	3	8	3	12
Chimneys or flues defective or overheated	3	3	5	17
Combustibles near heaters	1	1	6	21
Flammable Liquids	12	9	12	56
Appliances, incl. lamps, blow torches, etc.	2	2	1	6
Miscellaneous other flammable liquid fires	10	7	11	50
Cutting and Welding	12	8	15	45
Lightning	6	5	4	28
Miscellaneous Known Causes	42	35	40	147
Total Known Causes	187	190	191	552
Per Cent of Total Building Fires	58.6	57.5	66.8	40.9
Undetermined Causes	132	141	95	795
Total Building Fires	319	331	286	1,347

The cause of a fire can often be removed through good fire prevention work. Most of the 319 large loss building fires would not have occurred had proper attention been given to fire prevention. It is recognized, however, that only rarely is the cause of a fire directly responsible for the fact that a particular fire becomes a "large loss"; other factors such as building construction weaknesses, the hazards of the contents, delayed detection or alarm, and the failure to provide automatic protection all enter into the picture singly or in combination to allow a small fire to become big.

Table B above gives information on causes of large loss building fires. Of the 1960 large loss building fires, 58.6 per cent were reported with known or probable causes. This percentage has been rising fairly steadily since 1953. This trend may reflect a greater awareness of the importance of investigation of all factors of large loss fires.

For comparative purposes Table B also gives data on causes during the last seven years from NFPA studies.

This Year's Large Loss Study

The 1960 large loss report is arranged to highlight the factors responsible for large loss fires. Occupancy factors, where important, are covered in the NFPA Occupancy Fire Records.*

The large loss fire report consists of a series of articles dealing with the significant features of the building fire experience followed by separate articles on the "Large Loss Fires Not in Buildings," and on "Large Loss Aircraft Fires." Summaries of fires are included to illustrate significant factors.

Each large loss fire is the result of a combination of factors. While a report on a particular fire may appear as an illustration of one factor, the writeup

*See NFPA list of "Publications on Fire Prevention" for data on these Records.

on each fire is intended to show all the major factors which were involved in the particular loss.

The series of articles on the large loss building fires is developed to emphasize the weaknesses that allow large loss fires to occur.

	Page
Spread of Fire	305
Private Fire Protection	327
Time, Place, and Origin of Fire	338
Detection of Fire	341
Alarm of Fire	349
Public Fire Protection	355

Table I, page 365, indicates the important factors responsible for large loss fires in recent years.

The report on "Large Loss Fires Not in Buildings" (page 369) describes fires involving property outside of buildings with separate reports on forest fires and transportation fire experience (other than aircraft).

Since aircraft and missile fires continue to take a toll of 25 per cent of the total annual large loss, they are separated into an article of their own for special study.

The 1960 large loss fire report ends with Table II, a record of all large loss fires grouped by occupancies. Fires that have been written up as illustrations can be located by use of the Index to Volume 54 starting on page 437 of this issue. Fires appear in the Index under the occupancy headings utilized in Table II.

Acknowledgment

This study is based on reports submitted by many individuals and agencies. The fire reports so submitted are in many cases the result of extra time and effort. They often include special sketches, plans, and photographs. They may be the result of hours of investigation and writing. It is to the people who submitted these reports — the fire chiefs, the fire marshals, the inspectors, the insurance industry, and the NFPA members who have given freely of their time — that this large loss story is dedicated, for without their support and interest the important factors of these fires would be lost.

1960 Large Loss Building Fires —

Spread of Fire

The 1960 large loss analysis proves again that large loss fires usually occur when fires spread over large areas. The principal means, therefore, for preventing large loss fires is the limitation of fire spread by the provision of fire walls, stairwell enclosures, and other fire-limiting structural features, and by the provision of automatic fire extinguishing equipment. (See Private Fire Protection.) It is true, of course, that a few fires each year cause a large loss without leaving the room or area of origin. These fires, however, are the exception as shown by the fact that construction weaknesses that permitted spread beyond the area of origin were a factor in 270 (85 per cent) of the 319 large loss building fires.

Two hundred and fifty reports of the 319 large loss building fires included the square feet of floor area involved. In these 250 cases 9,226,696 square feet of floor area were involved. This is approximately 212 acres. In such an area 307 football games could be played simultaneously each on its own field.

The following material is divided into subsections that cover the extent of fire spread and construction features which influenced the spread of fire.

Extent of Fire Spread

Confined to Room of Origin

In 3 cases (0.9 per cent) the fire did not spread beyond the room or area of origin.

Confined to Floor of Origin

In 14 cases (4.4 per cent) the fire spread beyond the room of origin but was confined to the floor of origin.

Confined to Building of Origin

In 225 cases (70.6 per cent) the fire spread beyond the room of origin and beyond the floor of origin to destroy the entire building.

Spread Beyond Building of Origin

In 60 cases (18.8 per cent) the fire was able to spread beyond the building of origin and into other buildings.

Outside Fire Spread into Building

And finally in 17 cases (5.3 per cent) a fire that started outside of the building was able to spread into it.

Dec. 12, Philadelphia, Pa., Crown Cork & Seal, Inc. $675,000.

Steel Fabricating (Can Fabricating). When a faulty electrical panel in the third story failed, sparks showered the immediate vicinity. Had an accumulation of cardboard boxes and paper scraps been removed from this area, it is possible that the fire would never have developed. As it was, the combustibles ignited and started a fire, which, in the high piled stock required 14 sprinklers for control. The water flowing in the sprinkler system set off the alarm bell in the central station headquarters. The alarm was relayed to the fire department which used hose lines to complete extinguishment. Though the fire damage was confined to the room of origin, smoke throughout the third floor area and water in the immediate fire area contaminated most of the tin cans and made them unsuitable for use, causing the heavy loss.

1960

Mar. 3, East Chicago, Ind., Sinclair Refining Co. 4 killed $500,000

PETROLEUM REFINERY (Industrial Laboratory). LP-Gas from the petroleum plant is usually brought to the laboratory in a 12 in. by 24 in. sample container. After remaining outdoors during the night the LP-Gas container was brought into the 60 ft. by 162 ft. 2-story brick, concrete-framed laboratory for normal test procedures. Sudden unexplained rupture of the container released the gas which was ignited by an operating Bunsen burner. The explosion killed four chemists and injured 5 other persons. The second story of the building was demolished. The ensuing fire was small and controlled rapidly.

Nov. 10, near Nogales, Ariz., Sinaloa Valley Cold Storage, Inc. $1,133,000

COLD STORAGE. The fire that destroyed this building and its contents of 700 tons of frozen shrimp originated in a pile of wooden pallets piled against the outside of the build-

Mike Blizzard

HOTEL, Atlantic City, N. J. When fire fighters answered an outsider's alarm at 5:24 P. M., March 23, the question was not whether the Hotel Wiltshire could be saved but rather whether fire could be kept from exposed buildings. The adjacent Governor Hotel was scorched and embers started an outdoor fire a block away, but otherwise the $300,000 fire was confined to the Hotel Wiltshire.

The unsprinklered 7-story wooden Wiltshire Hotel was closed for the season. On the afternoon of the fire carpenters and electricians were renovating the lobby and repairs were being made to the roof.

ing. The reason that the fire eventually spread into and through the building will be understood from a description of the building and the fire protection available.

The 100 ft. by 200 ft. 1-story building was steel-framed with aluminum cladding. Walls were lined with 6-inch-thick polystyrene foam insulation to which plaster had been applied. The ceiling consisted of polystyrene foam supported by wooden furring strips which were in turn attached to steel framing. The building had no automatic fire protection, no watchman protection and was located in an area that had no public fire protection.

Discovery was by a neighbor at 5:57 A.M. By then the heat of the fire in the pallets had ignited the polystyrene foam wall and ceiling insulation, and the entire interior of the building seemed to be in flames when firemen from nearby Nogales arrived.

On learning that the fire involved a building outside the city limits and that no city property was exposed, the firemen returned to quarters.

Aug. 26, San Rafael, Calif., O'Neill & Logan Hardware Co., et al. $437,000

Jim Kean

HARDWARE STORE. Ten minutes after this unsprinklered store had closed for the night smoke was seen coming from a roof ventilator. Fire fighters responding to the alarm saw no flames. On attempting to force entry into the building, three fire

Courier-Journal and Louisville Times

LUMBERYARD, Louisville, Ky. One of 60 large loss fires in 1960 to spread beyond the building of origin on March 13. Originating in a private garage, this fire spread to a large unsprinklered 2-story wooden warehouse of the Kentucky Lumber Co., which was loaded with builders' supplies. This spread of fire caused $555,000 loss.

fighters were blown back about 15 feet by an explosion which is thought to have been caused by ignition of fire gases and vapors from released paint.

Destroyed within the building were offices, a drapery store, and a floor covering and appliance store. Flames destroyed two automobiles and sparks ignited lumber several hundred yards distant.

Building Construction

All types of buildings were involved in the 319 building large losses of 1960. Three fires (0.9 per cent) occurred in buildings of fire-resistive construction; 38 fires (11.9 per cent) occurred in noncombustible buildings; 20 fires (6.3 per cent) in buildings that had combustible roofs but otherwise noncombustible construction; and 149 fires (46.7 per cent) burned in buildings of masonry, wood-joisted construction. All-wooden buildings experienced 57 fires (17.9 per cent); wood-framed, metalclad, 19 fires (6.0 per cent); mixed construction, 22 fires (6.9 per cent); buildings of miscellaneous other construction and those for which construction details are not available accounted for the remainder.

Oct. 3, Vicksburg, Miss., U. S. Army Engineers, et al. $1,349,000

GOVERNMENT OFFICE BUILDING. The fallacy of keeping valuable equipment and

Ed. McHale

irreplaceable records in unsprinklered combustible property is again brought out by this fire. Starting in the cafeteria on the first floor of the 2-story building, fire was discovered by a guard at 2:58 A.M. It is not known how long it may have been burning since there was no watch station in the area.

Robert Wallace

METAL PRODUCTS STORAGE, Leetsdale, Pa. Noncombustible construction and predominantly noncombustible contents are no guarantee against a disastrous loss when the building is unsprinklered. This building, which was occupied by the Standard Can Corp., et al, was destroyed by fire on April 14. It was used for storage of metal waste baskets, coolers and other metal equipment. None of these contributed to the $433,000 fire, but the combustible cartons in which they were packed did, as did also some plastic and paper products stored in the building.

Nova Scotia Fire Marshal

PUBLIC SCHOOL, Kennetcook, N. S. The combustible section of the Hants North Rural High School was destroyed by fire on Nov. 26. **See report on page 330.**

Fire spread through the main wing and three wings perpendicular to it before being extinguished by fire fighters at this Waterways Experiment Station and by fire companies from Vicksburg. The walls of this sheet metal-covered, steel-framed, but otherwise combustible building were not firestopped nor were the attics subdivided to assist in limiting fire travel.

Included in the loss was an electronic computer (valued at $400,000); all presses and other equipment in the print shop; all of the photography laboratory including cameras; the entire technical library; practically all desks, typewriters, etc.; and some personnel files. Most of the classified material was in fire-resistive containers and was recovered. When it became apparent during fire fighting operations that the building itself could not be saved, hoses were played on some files containing finance, accounting, and personnel records.

Proposed plans for erecting replacement buildings call for sprinkler protection.

July 4, Lafayette, Calif., John P. O'Shea $250,000

DWELLING. Ignition of a wood shake roof covering by fireworks from a public display a "good distance" down the street was the probable cause of fire that destroyed 75 per cent of the roof and 70 per cent of the interior of this 4,483 sq. ft. 1-story wooden home. The owner dozed off while reading in the library but was startled awake when the electric lights suddenly went out. The fire was well developed on and had spread under the wood shake roof. The alarm was promptly telephoned to the fire department slightly over an hour after the end of the public fireworks display. Damage included an art collection and library with a reported value of $100,000.

Building Subdivision

Horizontal Fire Divisions

The principal structural factor in the horizontal spread of fire is the failure to provide adequate division walls. Absence of such a division wall (instances where good judgment would have recommended subdivision) was noted in 206 (64.5 per cent) of the fires. Substandard construction of the wall itself was a factor in 2 cases (0.6 per cent).

In 22 cases (6.9 per cent) openings in the division wall were a factor in the horizontal spread of fire. In 11 cases window or door openings were unprotected while in 4 instances unprotected conveyor or belt openings allowed fire to spread through the barriers. Three division walls were protected in a substandard manner. Four fire doors were blocked open or were otherwise inoperative thereby permitting fire to spread beyond the division walls in which they were installed.

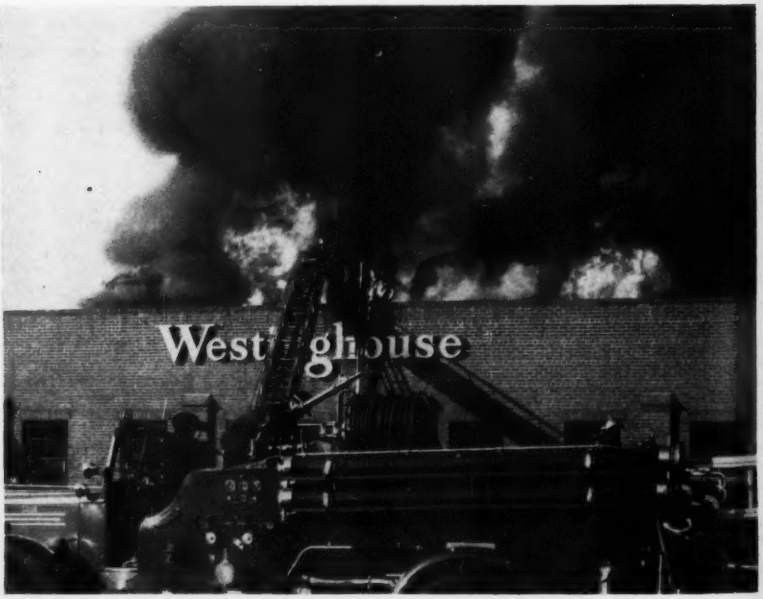
Horizontal Spaces Not Firestopped

The second major structural weakness affecting horizontal fire spread is nonfirestopped concealed spaces. Of the 27 fires (8.5 per cent) in which this construction weakness showed up, 23 (7.2 per cent) involved nonfirestopped concealed spaces above ceilings where good judgment would have suggested subdivisions. The remaining 4 fires were in other nonfirestopped concealed spaces.

May 29, Joliette, P. Q., J. Sansoucy et al. $270,000

CLOTHING STORE. When neighbors discovered fire at 3:50 P.M. on this Sunday, combustibles in the yard at the rear of a dry goods store were burning. Men on first apparatus arriving in response to the alarm found the entire back of the building a mass of flame. Although there were party walls between the building of fire origin and each adjacent structure, they were poorly constructed and thus did not prevent the spread of fire to the abutting structures while hose lines were being placed in operation. The fire involved four buildings containing as many retail stores and housing more than 20 families in upper story apartments. The Joliette fire department, received mutual aid from its auxiliary department and Montreal fire fighters. Together they gained control of the blaze.

Joliette Gazette

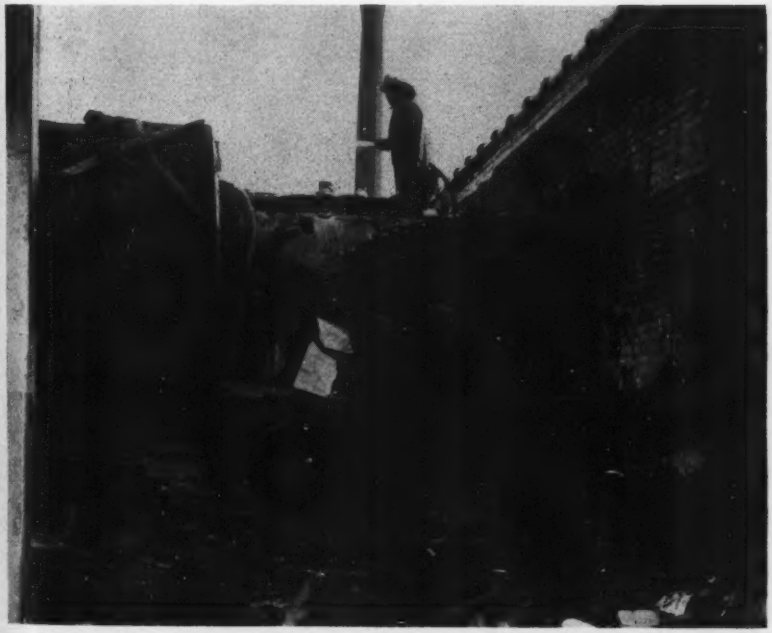


Oakland Tribune

ELECTRICAL APPLIANCE, SUPPLIES STORAGE, Oakland, Calif., Oct. 4. A division wall with openings protected by automatic fire doors confined fire damage to half of this unsprinklered 100 ft. by 150 ft. 1-story brick, wood-joisted warehouse. The fire originated in that part of the warehouse occupied by the Westinghouse Electric Corp. for storage of household appliances and electrical contractors' supplies. It was discovered by a passer-by at 7:11 A.M. and burst through the roof when fire fighters raised a large rolling steel fire door. Fire destroyed the section of the building where it started. The adjoining section, occupied as a roofing company warehouse, was undamaged by the $602,000 fire, due to the effectiveness of the intervening division wall with fire doors at openings.

Bob Place

SHOPPING CENTER, Harwichport, Mass. Since there were no fire cut-offs between stores or within the attic over the supermarket, fire, starting in the latter area on Dec. 6, swept unchecked through it into four adjoining stores. An electrical short circuit in the unsprinklered concealed space between the suspended metal ceiling and the wood-joisted roof caused the $250,000 fire.



Buffalo Courier-Express

FURNITURE STORAGE, Buffalo, N. Y. Fire starting in the basement of the 1 to 3-story unsprinklered A. J. Spangenthal Furniture Co. was discovered by a neighbor at 5:25 A.M. on Jan. 25. Although there were division walls in the property, fire doors at openings through them were blocked open. Absence of complete physical barriers allowed rapid spread. Fire fighters, responding to 4 alarms, used 15 2½-inch hose lines in extinguishing the $310,000 fire.

Vertical Openings Not Enclosed

The principal factor in the vertical spread of fire is the failure to enclose vertical openings or the failure to provide standard enclosures for these openings. In 113 cases (35.4 per cent) this was the reason for extended vertical spread of fire.

Open stairways accounted for 51 of these 113 cases. Open elevator shafts were a factor in 8 fires (2.5 per cent); conveyor openings in 15 fires. There were 10 other unprotected openings of various types affecting vertical fire spread.

Substandard enclosure of stairways, elevators and other vertical openings accounted for 29 cases of fire spread (9.1 per cent of building fires).

Vertical Spaces Not Firestopped

The second largest factor in the vertical spread of fire is the nonfirestopped concealed space. Of the 51 vertical concealed spaces involved in this year's large losses 47 were within walls.

Feb. 12, Gainesville, Ga., First Baptist Church $600,000

CHURCH. The part that nonfirestopped walls can play in spread of fire is illustrated by the blaze that destroyed the large church in Gainesville, Ga. Answering a alarm given by police at 9:30 P.M., firem found a fire in the basement of the unspri klered 10,000 sq. ft. 3-story stone, stee frame church. They entered the baseme and attacked the fire unaware that fire w also burning in the attic until it burst fro the roof. The fire reached the attic fro the basement by way of nonfirestopp spaces in walls.

Dec. 24, Garden City, N. Y., Garden Court Apartme Building $300,000

APARTMENT. The basement garage whe this fire started was sprinklered and was c off from upper floors by a fire-resistiv ceiling. Thus, any fire originating in th garage should have been extinguished with out any threat to tenants. Due to a lack c care neither the sprinkler protection nor th cut-off provided the protection expected.

The fire originated in a storage closet i the garage during the night. When a tenan finally awoke at 3:00 A.M. and notice smoke, flames were spreading verticall through nonfirestopped walls to a 4-foot deep concealed space between the roof an ceiling of the top story of the 4-story brick wood-joisted building. The tenant an janitor spent 16 minutes looking for th source of smoke before attempting to tele phone the alarm. When the wiring burned the phone went dead and the lights went ou before the alarm could be given. It wa finally transmitted from a public telephon around the corner. (Continued next pag

Vancouver Fire Department

SAW, PLANING MILLS, Vancouver, B. C. Fire, due to a welding operation, started in an undivided, unsprinklered concealed area under this large British Columbia Forest Products, Ltd., plant. The July 3 loss was $2,981,000. See report page 360.

Drennan Photo Service

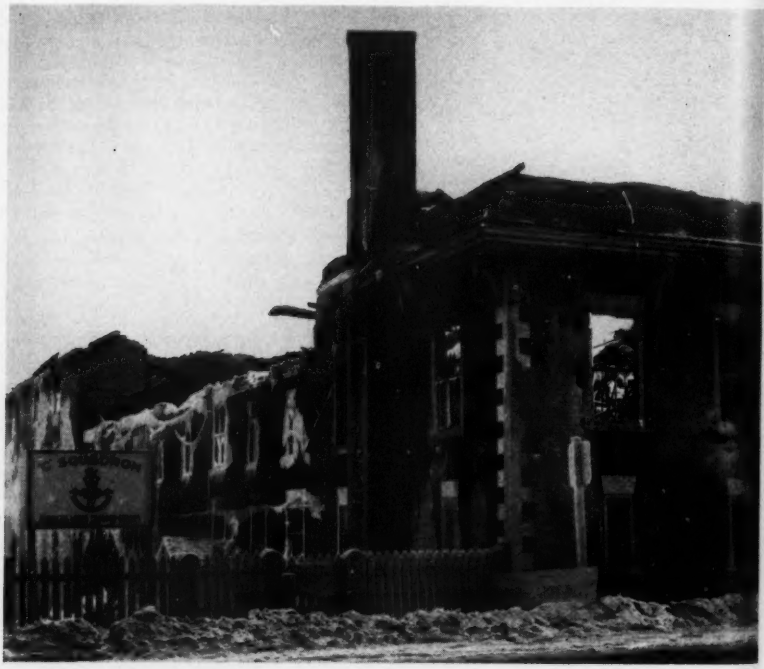
On arrival police and firemen hurried through the corridors pounding on doors to rouse tenants. All escaped safely down interior stairways.

First firemen to enter the garage reported that only a dribble of water was coming from sprinklers. Since the control valve was found open following the fire, investigators lean to one of two possible explanations for this condition. One was that the 4-inch water supply which also served as the domestic supply to the building may have been overtaxed by simultaneous domestic demands. The more probable explanation was that the system had frozen in the vicinity of the garage door. The outdoor temperature was 10°F. and the garage door was found partly open by firemen.

There was no question of how the fire got from the garage to upper floors. It spread through holes that had been made in the concrete garage ceiling in connection with plumbing, heating and electrical changes in the building. Passing through these holes, flames spread vertically through nonfirestopped pipe shafts and spaces within walls.

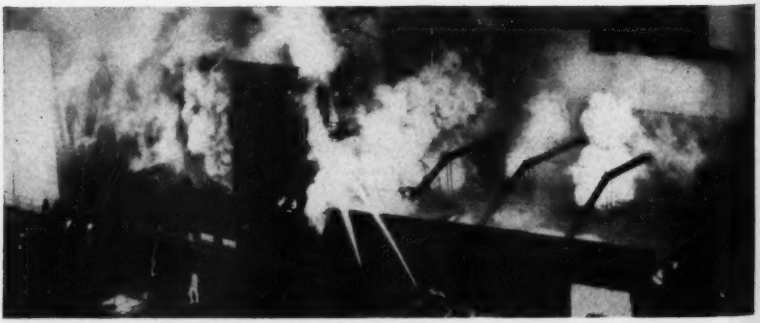
Courier-Post Photo

PRIVATE DAY SCHOOL, Camden, N. J. Open stairways, concealed wall spaces, and undampered ventilating ducts provided easy paths for vertical fire spread in this high school building on April 17. Starting in the basement, flames burned into the first-floor auditorium and on entering nonfirestopped ducts and wall spaces, spread to the blind attic before discovery by a nun in a nearby convent. A 12- to 16-inch-thick fire wall parapeted 2 feet above the roof failed to confine the flames to the area of origin as the wall was pierced on each floor by unprotected openings.



J. A. Morris

ARMORY, Prescott, Ont. Absence of fire walls to subdivide the property horizontally and fire stops in the hollow walls to provide vertical subdivision allowed fire, starting in the loft on Jan. 23, to spread unchecked through the combustible interior of the Prescott Armouries. Before being discovered by a watchman (who made rounds only through a section of the property), fire was so well established that fire fighters' efforts to limit its spread were unsuccessful. Damage is estimated at $500,000.



Tony Tomsic

NIGHT CLUB, Cleveland, Ohio. The honeycomb of concealed spaces made in the Theatrical Grill night club during a recent $250,000 renovation created channels for fire to spread horizontally and vertically out of reach of fire department hose streams. No sprinklers had been provided, requiring the use of an extremely large amount of water for control of the Sept. 13 blaze. **See story on page 353.**

Democrat Chronicle

CHURCH, Rochester, N. Y. At 6:16 A.M., Jan. 23, several hours after an evening meeting attended by 700 had disbanded, a passerby saw flames coming from this 3-story stone, wood-joisted temple. The fire originated in the first-floor dining service area and spread up an open stairway to the undivided attic. The damage to Temple Beth-El was over $250,000.

Vertical *AND* Horizontal Openings

The action of a typical fire, spreading both horizontally and vertically, is well illustrated in the following case.

May 27, Harrisburg, Pa., Youth Center, et al. $1,200,000

CLOTHING STORE. It might be said that fire was slow in starting in this 3-story 7,070 sq. ft. unsprinklered building. A wood floor joist adjacent to the 3-inch high pressure steam service line where it entered the basement had carbonized over a period of years because of exposure to high temperatures. Flaming combustion finally developed and fire spread to nearby racked orlon merchandise stored in plastic bags. Flames then traveled up a stairway to the first story and throughout the rest of the brick-walled, steel frame building via air-conditioning system ducts. The building of origin was destroyed and those on either side suffered heavy water and smoke damage.

At the height of the fire 27 hose lines were used by 21 fire companies responding from Harrisburg and 7 other communities.

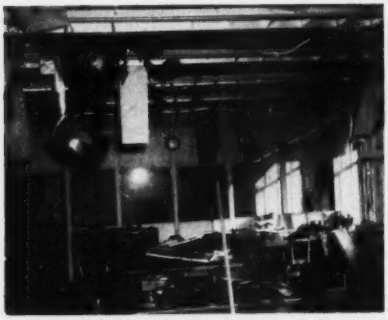
Interior Finish

In 40 fires (12.5 per cent) the combustibility of the interior finish was a factor in the outcome. In 31 of these fires combustible fiberboard, either acoustical tile or sheets, was the interior finish influencing fire spread.

The remaining 9 interior finish fires involved other types of finish such as pressed hardboard and plywood.

July 7, Schenectady, N. Y., General Electric Co. $496,000

ELECTRICAL APPLIANCES, ASSEMBLING. (Office Building.) Electrical failure in one of six air conditioners in the sprinkler-



Schenectady G. E. News

protected space between the third-story ceiling and roof of a 300-ft.-long building is thought to have started a fire on July 7 in the unsprinklered plenum running its entire length. The plenum, 10 ft. wide at top, 6 ft. wide at bottom and 5 ft. deep, was constructed of combustible fiberboard on wood frame and contained two metal air supply ducts covered with noncombustible insulation having asphalt paper backing. It is reported that heat released from the fire in the plenum fused 107 sprinklers above it and 61 sprinklers in the third story below it. This unusually large number operated because water discharge did not effectively reach the seat of the fire but was instrumental nevertheless in limiting fire damage to the vicinity of the plenum. Several 1½-inch hoses and three 2½-inch hoses were used during a 3-hour period to extinguish the $496,000 fire.

Extensive salvage operations were required to reclaim 2,800 soggy volumes of irreplaceable photo files and minimize damage to typewriters and various other office machines from water.

Building Equipment

Failure to cut off boiler rooms and other hazardous areas was responsible for the spread of fire in eight cases. Duct systems spread fire and smoke in 14 fires, air-conditioning equipment in two.

March 9, East St. John, N. B., Maritime Cartons, Ltd. et al. $425,000

PAPER PRODUCTS FABRICATING. About 5:30 A.M. a fire occurred in the furnace room on the first floor of this 200 ft. by 400 ft. 1-story wooden unsprinklered paper box factory. The boiler was not in a fire-resistive room. A minor explosion is reported to have occurred, rupturing the substandard wall to the boiler room. Fire spread through this opening to wax and cleaning fluid stored immediately outside the room. Flames then spread through the undivided structure.

High winds forced flames against the end of a storage building 10 feet away of similar construction to the factory but sprinklered. The intense heat opened so many sprinklers that the water supply was unable to control the fire. Flames spread into this second building, destroying it also.

June 22, Fort Smith, Ark., Landers of Arkansas, Inc. $1,230,000

ELECTRICAL APPLIANCES, ASSEMBLING. The 7,500-sq.-ft. buffing room in which aluminum parts were ground and polished was separated from the rest of the 111,000-sq.-ft. 1-story noncombustible building by concrete block walls, one of which had three unprotected openings. When the fire broke out in cutting oil at an automatic grinding machine, employees attacked it with a large carbon dioxide extinguisher but were unable to prevent flames from spreading over oily deposits on machines and building members.

Heat caused the asphalt vapor seal to come through the joints in the metal roof deck and provide additional fuel for the fire. The fire did not spread beyond the unpierced concrete block walls but did spread beyond the wall with the openings and eventually involved an area of about 18,000 sq. ft. That more of the building was not involved was attributed to fire fighting by employees and the public fire department and to the fact that heat and smoke were vented through holes that opened in the sagging unprotected steel roof.

About 25 per cent of the plant was sprinklered, but none of the area involved in the fire was protected.

Wide World by Lt. Robert Kennedy, P.F.D.

CHURCH, Philadelphia, Pa. This fire on March 10 originated in the boiler room of the Bethany Temple Presbyterian Church while a group of parishioners were cleaning up after a family night. Discovery was made by a passerby who warned the occupants in time for all to escape safely. The boiler had recently been enclosed with a cinder block wall, but the old wood lath and plaster ceiling overhead was not changed nor were rusted-through flue pipes replaced.

During the $322,500 fire a hydraulic jack on the aerial ladder truck shown in the photo slipped and allowed the ladder to fall. The second photo shows ladderman Matthew Harkin attempting to swing the big stick away from the building and save his comrades as the ladder falls. The three men on the ladder at the time were injured.

Oct. 9, Williamson, W. Va., Mountaineer Hotel $250,000

HOTEL. Reporting for work at 10:25 A.M., the chef turned on the electric deep fat fryer in the first-floor kitchen, left to get supplies in a storeroom and on returning five minutes later found the fryer in flames. After emptying a 6-pound carbon dioxide extinguisher on the fire without putting out the fire, the chef notified the hotel manager in the lobby who, with another employee, brought a 6-pound carbon dioxide extinguisher and a 2½-gallon water-type extinguisher to the kitchen. With these the fire in the fryer was extinguished, but to be on the safe side the fire department was asked to "come to the Mountaineer Hotel kitchen."

Arriving firemen saw flames coming from the roof of the 5-story brick, steel-framed building where they had spread via the exhaust duct from the first-floor kitchen. The duct was not enclosed in a masonry shaft as required by the NFPA Standard for Ventilation of Restaurant Cooking Equipment (NFPA No. 96). The substandard feature allowed heat from the fire in the duct to ignite the wood roof. Fire damage was confined to the roof but water and smoke damage to the rest of the building was heavy.

Building Contents

If a building is fire resistive in construction and finished with noncombustible materials, then the only remaining fuel for fire is the contents of the structure. In 166 fires (52.0 per cent) one or more of the contents features of the building was a factor in the outcome.

Flammable Liquids

First on the list of complicating contents factors were the 79 flammable liquids fires. In 27 of these the liquids escaped from tanks and drums, in 13 cases a flammable liquid container rup-

tured. In 15 cases the liquids involved were in process equipment, in 7 cases piping failed or ruptured, and in 3 others the flammable liquid escaped from fuel tanks of vehicles or planes. Flammable liquids influenced extent of damage in various ways in the remaining 14 fires.

Improper Storage Practices

The next largest contents factor was improper storage. Of the 61 cases where storage methods contributed to the extent of damage, 23 were due to poor stock subdivision, 22 to stock that was piled too high, and 5 to inadequate clearance between stock and windows or walls. Eleven cases involved other storage factors.

Dust Conditions

In 34 cases dusty conditions produced by the nature of the contents seriously contributed to fire spread. In 29 of these cases dust was on structural members, and in 4 dust explosions occurred. In one instance fire was spread by rubber buffing dust.

Poor Housekeeping

In 30 cases poor housekeeping was a factor in the fire spread. In 10 cases oily or greasy deposits were a problem, in 5 cases the accumulation of rubbish was a factor, and the remaining 15 were due to various causes.

Gases

There were 26 fires where gases were a factor. Nine fires involved natural or manufactured gas, 6 involved liquefied petroleum gas, 6 acetylene, 1 ammonia and the other 4 involved chlorine, hydrogen and ogygen.

Gas escaped from piping in 10 cases; gas container explosions occurred in 5 cases; and gas escaping from cylinders and storage tanks was a factor in 5 cases. In the remaining 6 cases gases were a factor for miscellaneous reasons.

There were 15 cases of other contents factors that were an influence on either fire spread or on fire fighting, such as the storage of explosives or ammunition.

Oct. 22, Lowville, N. Y., American Machine & Foundry Co. $300,000

HARDWOOD TURNING PLANT (Bowling Pin Finishing). On the second floor of this 300 ft. by 65 ft. 2-story wooden building, bowling pins were conveyed through a dip tank of cellulose nitrate lacquer and a long drying tunnel. The building was protected by automatic sprinklers, but the enclosure housing the dip tank and drying operation was not. No automatic carbon dioxide or dry chemical protection was provided for the dip tank and dry tunnel nor did the dip tank have a dump valve and overflow drain connected to a salvage tank.

While the dipping and drying operation was in progress, fire broke out in the vicinity of the dip tank. In a very short time the entire dip tank and dry area were in flames and burning flammable liquid was spreading over the floor. Sprinklers operated to keep the fire from spreading and from igniting structural members, but due to the dense smoke and the shielded fire in the dip tank and dryer enclosure they were allowed to operate for 2½ hours until the fire had been extinguished by hose streams directed from outside the building. Sprinklers also controlled fires that broke out in the first story when burning flammable liquid came down through second-story flooring.

The flammable liquid on the floor around the dip tank must have come from the tank. Since it was the practice to maintain a 1-foot freeboard in the 3-ft.-deep dip tank, investigators do not believe the tank overflowed. An explosion was felt almost immediately after the fire was discovered suggesting possibly that the concussion of a flammable vapor explosion blew flammable liquid out of the tank.

Oct. 24, Central Islip, N. Y., Central Islip State Hospital $510,000

MENTAL INSTITUTION (Hospital Supplies Storage). The folly of storing valuable material in buildings without sprinkler protection and in violation of fundamental storage principles was demonstrated by this fire

Drennan Photo Service

that destroyed equipment for mobile hospitals and field aid-stations. This equipment, supposedly vitally needed in case of enemy attack, was stored in what was essentially a huge pile without aisles in the second story of the unsprinklered 2-story brick, wood-joisted building. Under these conditions, the stock was exposed to complete destruction by a single fire.

Mar. 18, Indio, Calif., Valley Date Gardens, Inc. $290,000

FOOD PRODUCT STORAGE. Improper arrangement of packed date boxes offset the early notification of fire over a connection from the automatic detection system to the fire department via the police dispatching office. Instead of being able to attack the blaze as soon as the building was ventilated, fire fighters first had to carry out hundreds of boxes to get at the burning area. Once the seat of the fire was located, control was soon accomplished. Smoke contamination and water damage to other dates in the 10,800 sq. ft. building had already occurred by this time, however.

Wide World

LIQUOR STORAGE, near Owensboro, Ky. This bonded whiskey rack warehouse and the contents of 20,000 barrels of whiskey stored 12 tiers high were destroyed by fire on June 30, probably from a lightning strike. The warehouse had no sprinkler protection, no lightning protection and was located outside the city limits of Owensboro in an area where water supplies for fire fighting were very weak.

Heat from the fire ignited the roof and window frames of another warehouse 102 feet away and the distillery 119 feet away. Damage to these buildings was minor due to the work of firemen who used what water was available to protect exposures.

Had it not been for the fact that the cellar hole of the building of origin was drained to a safe location, it is probable that flowing burning whiskey would have spread the fire to other buildings.

Mar. 4, Henrietta, N. C., Burlington Industries, Inc. $300,000

COTTON STORAGE. While cotton was being stacked in the 1-story sprinklered warehouse a lift truck backed into a pile of bales starting a fire. A brief attempt to put out the fire with a vaporizing liquid extinguisher was futile as the fire flashed over cotton stored in two adjacent piles containing a total of 2,300 bales.

The dry pipe sprinkler system was supplied by a 150,000-gallon standpipe (55,000 gallons 35 ft. above the highest sprinklers), a 1,000-gpm steam fire pump and a 750 gpm gasoline engine fire pump. Although there was an adequate water supply for sprinklers (even before operation of the pumps), the sprinklers were unable to control the fire due to the height of the piles (up to 12 bales high stacked on sides) and the lack of subdivision of piles. The fire pumps were started promptly. Employees also, however, soon had 11 hose streams supplied by yard hydrants in operation. Water demand of these streams exceeded the pump capacity with the result that the sprinkler supply was seriously depleted. Thereafter the wood roof of the 75 ft. by 75 ft. brick, wood-joisted building collapsed.

About three hours after the roof collapsed, the retaining nut on one of the pistons of the steam pump came off. The pump was out of service for three hours for repairs. The gasoline fuel pump of the gasoline-driven pump failed soon after the steam pump shut down. A manually operated gasoline feed pump was used thereafter to keep the gasoline-driven pump operating.

Wide World

FLOUR MILL, Port Colborne, Ont. A flour dust explosion occurred about 8:00 P.M. on Oct 7 in the third and fourth floors of a 4-story, wood- and steel-framed, corrugated ironclad building. These areas were used for flour bleaching and packing, respectively. Cause of the explosion has not been determined but may have been due to malfunction of a chlorine dioxide generator or by ignition of a dust cloud in a flour agitator. In a very short time, ensuing fire spread to similarly constructed adjoining buildings and then across a yard area to four other multistory buildings housing the bag factory and finished goods.

Plant fire pumps were started and the fire department was called promptly. Even so, the fire was beyond the public department's control when it arrived. Automatic sprinklers in the building of origin were not effective because piping had been broken by the explosion. Those sprinklers remaining intact in exposed buildings could not cope with wide fire fronts offered by burning exposing buildings.

Fire fighters had difficulty in attacking the fire because of limited land space between buildings and because of water on three sides of the property. A fire boat from Buffalo, N. Y., was sent to aid and delivered water on one end of the fire which was completely beyond reach of land apparatus.

Early attempts by fire fighters to rescue an employee from the building of origin had to be abandoned due to threat of floor collapse. Minutes after the men were withdrawn, machinery was heard crashing through floors. The trapped employee was killed and six others were hospitalized.

Apex Photos

WOOD FIBER PRODUCTS PLANT, Gatineau, P. Q. Fire that destroyed half of International Fibreboard Ltd.'s sprinklered plant on Feb. 20 originated in a pile of wrapped asphalt-impregnated fiberboard which was being allowed to cool. See report on page 331.

Boron Enterprise

CHEMICAL AND DRUG STORAGE (Paper bags, Ammonium Nitrate storage), near Boron, Calif. Fire of suspicious origin on May 10 first involved paper bags at one end of an unsprinklered warehouse but it soon spread across these bags through the undivided 12,336 sq. ft. building to 20 bags of ammonium nitrate at the other end. Instead of following the regular procedure for attacking fires involving ammonium nitrate — use of large quantities of water — plant and municipal fire fighters withdrew believing that an explosion of the ammonium nitrate was imminent. No explosion occurred as the building and its contents were completely destroyed. Loss was $250,000. As outlined in the article, Ammonium Nitrate — Behavior in Fires, in the 1960 NFPA QUARTERLY, there is considerable evidence that ammonium nitrate exposed by fire does not explode under normal storage conditions.

March 29, Cincinnati, Ohio, U. S. Drill Head Co. $252,000

STEEL FABRICATION (Machine Tool Manufacturing). When employees smelled gas on March 28 they opened windows but did not notify the utility company or municipal emergency services of the unsafe condition. The gas, later found to be coming from a leak in an underground distribution main, is believed to have entered the building through voids in the concrete block wall. The accumulation was ignited sometime after the plant closed, and fire was discovered by a passerby who notified the night watch at a fire station at 4:28 A.M.

Although there was a fire detection system, it did not operate until 28 minutes after the alarm was given by the citizen. The supervisory company, to which the system was connected via leased telephone lines, had received an open circuit trouble signal at 4:08 A.M. but the only action taken was to contact the telephone company. When the fire alarm signal was finally received at 4:56 A.M. in the central station office, it was not passed along to the fire department for 29 minutes.

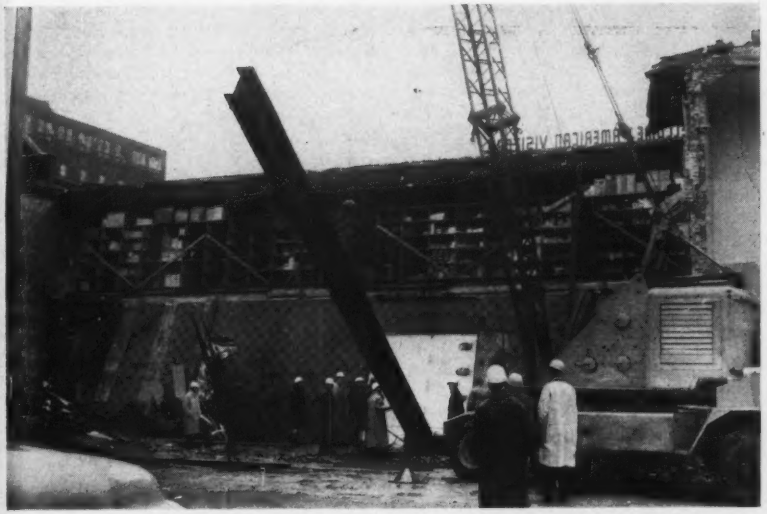
Dec. 31, near Macon, Ga., Mead Corp. $350,000

PAPER MILLS. Several years ago ash dropping into the bottom of a 300-ft.-high brick industrial stack at this mill ignited. The intense fire took a layer of brick off the inside of the stack. When rebuilt the stack was relined and bands were placed around the bottom half of the stack.

Following a holiday plant shutdown the boilers were prepared for reignition. After what appeared to be a proper purge period the boiler was about to be ignited when a fuel gas-air mixture ignited explosively in the fire box. The top 150 feet of the stack was blown off. The bands held the bottom half together. A new stack is being constructed.

Wide World

PUBLIC SCHOOL, Wauseon, Ohio. On Saturday afternoon, March 19, two plumbers were in the 2-story elementary school attempting to open a sewer line when an explosion leveled a large part of the building. Investigators found a leak in gas piping in the alley beside the building that permitted natural gas to accumulate in the crawl space under the building. It was this gas that is believed to have exploded.



Windsor Star

DEPARTMENT STORES, Windsor, Ont. During installation of a conversion gas burner in a former coal-fired heating boiler, purging of air from the gas service supply line was attempted at a ½-inch union on the pilot line at the front of the boiler. When workmen were unable to get the pilot lit, they disconnected the 2-inch union between the 3-inch main valve and the meter in order to bleed the supply at that point. Although the control valve had been throttled somewhat, a large quantity of gas was permitted to enter the basement and the flammable gas-air mixture ignited explosively. An operating coal-fired hot water heater probably provided the source of ignition. The rear wall of the 2-story brick, bar-joisted Metropolitan Stores, Ltd., building was blown out, allowing the back section of the structure to collapse. Ten of the approximately 150 customers and employees in the store were killed and 75 were injured in this Oct. 25 disaster.

Exposure Fires

No study of fire spread would be complete without a mention of exposure fires. In 77 fires the exposure problem was a big factor in fire spread. Sixty fires spread from the building of origin to one or more other buildings, while 17 outside fires spread into buildings. In these fires one or more of the following items was a factor in the fire spread (listed in order of importance): inferior combustible construction (24), inadequate separation between buildings (17), poorly constructed party walls (15), explosion (10), ordinary glass windows (9), yard storage between buildings (4), interconnecting passageways, conveyors (2).

Oct. 27, Calgary, Alta., Concord Investments Ltd. $325,000

Duffoto — Calgary

(Story on page 324)

BUILDINGS UNDER CONSTRUCTION. Four 2-story apartment building under construction were destroyed and a fifth was damaged by fire that broke out in a second-story kitchen of one of the combustible buildings (combustible throughout except for brick veneer on the ends). A propane torch being used by a plumber to sweat a baseboard heating pipe is believed to have ignited a wax-coated paper vapor barrier. This vapor barrier was over mineral wool batts and due to the fact that interior wall finish had not as yet been applied, the coated paper constituted the interior finish of the buildings.

The fire spread so rapidly that the plumber had no choice but to flee leaving his equipment behind.

Exposed plywood sheathing on buildings, unprotected window and door openings, and 30 mph gusty winds allowed the fire to spread quickly to exposed buildings where it spread rapidly over the exposed waxed paper vapor barriers.

Fire fighters were able to save part of one building under construction that was in the path of the flames and kept fire from a contractor's shed containing explosives and gasoline.

April 14, Pine Bluff, Ark., H. S. Lee Bulk Oil Plant, et al. $287,000

PETROLEUM BULK PLANT. After leaving his gasoline tank truck near the five undiked 12,000-gallon horizontal steel tanks on steel

Art Dietle

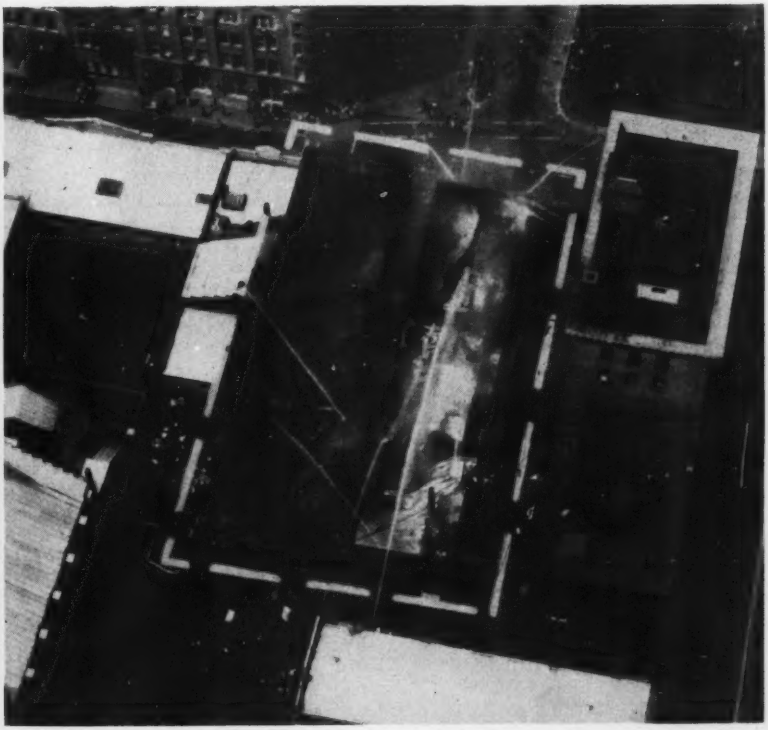
BUILDING BEING DEMOLISHED, New Haven, Conn. Despite diligent efforts by the public fire department, radiant heat from fire in a vacant loft building ignited the St. Louis Catholic Church and School across the street. The $600,000 loss on Aug. 29 started when sparks from an acetylene torch being used to remove sprinkler piping on the first floor fell into combustible waste in the former piano factory. The alarm was delayed by the welder who fought the fire instead of calling for help first. Fire spread was rapid as the roof and all windows had been removed. Part of the walls and roof of the exposed church collapsed and the exposed school was damaged extensively.

Demolition procedure for large sprinklered buildings calls for maintenance of sprinkler protection in all floors until demolition reaches the floor above. Had this procedure been followed, this loss would not have occurred.

supports, the driver went to the office for unloading instructions. While talking to the manager he saw fire near the tanks and the fire department was called promptly at 4:45 P.M. The fire did not appear too severe upon arrival of first apparatus but a second alarm was ordered as a precautionary step. Despite quick hookup and use of three 2½-inch lines, the gasoline storage tanks began rupturing 10 minutes later.

None of the five tanks was equipped with an emergency vent but all had normal breather vents. The unprotected steel supports under the tanks failed allowing the tanks to drop to the ground. All tanks ruptured from overpressure and one rocketed 60 ft., landing about 20 ft. inside of an adjoining fertilizer mixing and packaging plant. A large portion of this 41,040 sq. ft. iron on wood frame building was immediately involved. The flammable liquids spread through the area and ignited three dwellings, a gasoline service station, an oil warehouse and a shop before the spread could be checked an hour after the initial explosion.

The life hazard of inadequate emergency vents on flammable liquid tanks is discussed in an article in the January 1960 QUARTERLY, reprint of which is available.



Daily News Record

DEPARTMENT STORE, Harrisonburg, Va. Before being seen by a night employee of a nearby bank, this Aug. 31 fire, starting in the first story of the 3-story Bargain Shop, had been transmitted through unprotected plain glass windows into an adjoining 1-story soda shop. Flames spread through the shop and through plywood-covered windows into a 3-story block with a clothing store on the first floor, a beauty shop and apartments on the upper floors. When fire fighters pulled in, the open stairway to apartments was blocked by fire and five persons had to be rescued by ladder before extinguishing operations could be started. By this time the building of origin was totally involved. All three buildings were badly gutted before the $315,000 fire was finally extinguished.

Tom Brunk

MACHINERY STORAGE, Lima, Ohio. Boys playing on a pile of wood pallets outside and adjacent to the Palmer-Donavin Manufacturing Co. warehouse set the pile afire on July 19. Thirty minutes later, when noticed by a motorist, the fire had spread into the undivided and unsprinklered 230 ft. by 120 ft. 1-story wood-framed, ironclad building containing building materials. Once inside, the fire spread rapidly through the stored material consisting of asphalt roofing, soft fiberboard, paper-backed insulation and other items stored in combustible cartons.

1960 Large Loss Building Fires—

Private Fire Protection

Most large loss fires become large because of the absence of private fire protection in high valued property; a few, because of the misuse, poor design, improper installation or inadequate maintenance of one or more of the various types of private fire protection. Typical examples of these latter cases from the 1960 large loss fire experience will be cited in this article.

Typical Fire with No Protection

Aug. 19, Suamico, Wisc., Suamico Box Co. $269,500

Wooden Box Plant. The fire that destroyed three communicating buildings — box factory, box warehouse, stock warehouse — is a good illustration of the fallacy of operating a plant without private or public fire protection.

Suamico is a small unincorporated village with an unorganized fire department. The box factory consisted of combustible buildings without sprinkler protection or water supplies for fire fighting. In other words, it should have been quite obvious to the plant operators that any fire that broke out would be likely to cause major damage unless discovered while still small enough to be controlled with extinguishers. However, no watchman was hired to watch the buildings during nonoperating periods with the result that fire that broke out during the night was not discovered until neighbors half a block away smelled smoke.

Firemen went to the fire station, and after one arrived with a key, drove their truck to the fire, where because of the extent of the blaze and the lack of water, their activities were limited primarily to clean-up.

Automatic Sprinklers

In 259 (81 per cent) of the 1960 large loss building fires, the lack of automatic sprinkler protection was a definite factor.

Glenn Hage

PLASTIC FILMS AND SHEETS FABRICATING, Princeton, Minn. The 200 employees of the Fingerhut Mfg. Co. escaped safely from this 50,400 sq. ft. 1-story building when fire spread rapidly through the undivided and unsprinklered building. See report on page 328.

In 1960, 43 automatic sprinkler systems were involved in large loss building fires. This is 8 more than the 35 involved in 1959. Twenty-six of the fires occurred in buildings protected by complete systems, while 17 occurred in buildings with partial systems.

In 15 cases (11 explosions, 3 severe exposure fires, and one fire in a building which was in an early stage of construction) there were no sprinklers and the provision of them would not have been a factor in the outcome of the fire. In 2 cases there was no information on sprinkler protection.

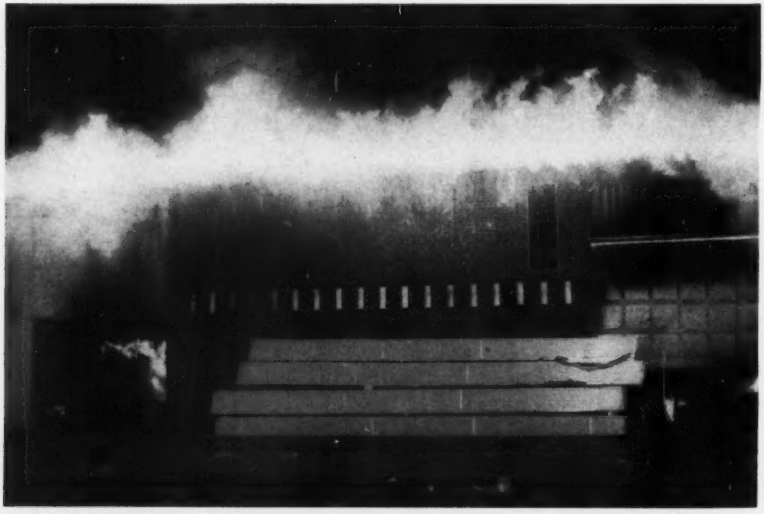
Any review of unsatisfactory sprinkler performance should mention the 1960 study of 67,457 sprinklered fires* which indicates that sprinklers perform satisfactorily 96.2 per cent of the time. The review here of sprinkler performance in the 1960 large loss fires will show graphically what happens when a sprinkler system is not designed for the hazard protected, is not backed up by a strong water supply, or is not maintained in operating condition.

*NFPA QUARTERLY Reprint Q54-5 (50 cents).

Typical Unsprinklered Fire

July 29, Princeton, Minn., Fingerhut Mfg. Co. $835,000

PLASTIC FILMS AND SHEETS FABRICATING (Plastic seat cover mfg.). Lack of automatic sprinkler protection was responsible for the destruction of this small town's biggest industry. The fire originated in the shipping room where an employee was using a cutting torch to make alterations to an overhead conveyor system. A guard who was posted to watch for possible fires left his post for a



Messenger Photo Service

PRINTING, TYPESETTING, Chicopee Falls, Mass. When passers-by saw this Dec. 8 fire for the first time flames were leaping 50 feet over the roof of the 32,000 sq. ft., 1- and 2-story building of mixed construction. The building belonged to the Rich Lithographing Co., one of the largest printing establishments in western Massachusetts.

Even the efficient fire fighting with master streams and many hand lines could not save the building, the payroll for the 160 employees or the new $365,000 imported 5-color press, or its $135,000 4-color mate.

While the fire cause is not known, the cause of the $1,082,000 loss is known — a valuable, large-area building without automatic sprinkler protection.

Lloyd S. Jones

VEHICLE ASSEMBLY (Railroad tank cars), Masury, Ohio. Fire that started in a paint drying booth about in the center of the 75-ft. by 960-ft. building, spread through the entire undivided and unsprinklered structure. It is estimated that the Oct. 22 fire burned for about 10 minutes before it was discovered by employees at 8:37 A.M. Flames spread in both directions feeding on paint and dust deposits. Included in the $3,000,000 loss were about 100 railroad tank cars in the plant for painting. Twelve hundred employees of the General American Transportation Corp. were thrown out of work by the fire.

few minutes and during his absence a fire started in a barrel of plastic cuttings. On finishing his job, the welder discovered the fire. Attempts to put it out with extinguishers had to be abandoned as the fire spread to stacks of boxed seat covers and generated great volumes of black smoke.

In the absence of automatic sprinkler protection and fire divisions, flames spread rapidly through the undivided 200 ft. by 252 ft. 1-story noncombustible building (masonry walls, steel framing, metal roof deck, built-up roof covering on combustible insulation). When the fire department arrived dense smoke pouring from doors and windows prevented entry and effective use of limited water supplies.

Completely Sprinklered Buildings

Of the 26 complete automatic sprinkler systems involved in large loss fires in buildings, 5 systems performed satisfactorily and 21 systems did not operate satisfactorily.

Closed valves were responsible for 8 of the 21 unsatisfactory performances. In three of these eight instances the sprinkler valves were closed prematurely (before the fire was extinguished), two valves had been closed for repairs to the systems, one valve was closed to abet arson, and two were closed for undetermined reasons.

Three of the 21 unsatisfactory performances of sprinkler systems were because the systems were not properly supplied with water. In one case there was insufficient public water for sprinklers and hose streams and in the other two there were insufficient private supplies for sprinklers and hose streams.

In 8 of the 21 unsatisfactory sprinkler cases the hazard of the occupancy was the reason for failure. In 5 of these, explosions damaged the systems and in 3 the occupancy hazard was too severe for the system as installed.

One of the 2 remaining failures was due to a defective dry valve and the other to an exposing fire which overpowered the sprinkler system in the exposed building.

Fires in Partially Sprinklered Buildings

Of the 17 partial sprinkler systems in buildings involved in the 1959 large loss fires, 2 systems were not a factor in the outcome as they were not in the fire area.

Six partial sprinkler systems operated satisfactorily in that they kept fire from spreading from the nonsprinklered to the sprinklered areas.

In 9 cases partial sprinkler systems were ineffective. In 4 of these, fire started outside but spread into the sprinklered area; in 2 there was insufficient public water for sprinklers and hose streams.

One of the 3 remaining cases was due to a defective dry pipe valve, one to a fire originating in an unsprinklered enclosure and one to a system of sprinklers that had never been connected to a water supply.

Feb. 17, Clifton, N. J., Velveray Corp., et al. $8,000,000

CLOTH COATING. The fire that destroyed this 4-story brick, plank on unprotected steel building 485 ft. long and 142 ft. wide was the result of a combination of fire protection weaknesses including premature shutoff of sprinklers, failure of building occupants to notify the fire department and failure of the fire department when summoned by an outsider to pump into the sprinkler system. A fourth fire protection weakness that was an important factor in the outcome was a vertical opening — in this instance a 1-inch crack between the building wall and flooring.

At about 8:50 A.M. a fire occurred in resinous dusts at wooden planking over a plastics laminating machine in the first story. Such fires were not uncommon, and as in the past employees attacked this one with portable extinguishers and did not call the fire department. The fire above the machine was put out with extinguishers and by the operation of one sprinkler.

The building occupants did not realize that during the period of the fire flames had entered the second story through a 1-inch-wide shrinkage crack between the second-story flooring and a brick wall. The post indicator valve in the yard that controlled the sprinkler system in that section of the building where the fire started (there were three other systems) was closed. At 9:02 A.M. employees in a building across the street saw smoke coming from second-story windows and telephoned the fire department.

Responding firemen saw the fire in the second story, and with the use of hose streams had practically extinguished it when it was discovered that the fire had also extended to the third story through cracks between the walls and flooring. It was probably at about this time that the fire fighters realized the extent of the fire and discontinued inside fire fighting. It was probably at about this time also that someone remembered to open the post indicator valve. By now, however, the fire had penetrated to the fourth floor and so many sprinklers had fused that the available water supply was overtaxed. The sprinklers had no effect either in adjoining sections of the extensive plant into which the fire spread rapidly at each floor level. At no time did the fire department connect to and pump into either of the two fire department connections to the sprinkler systems.

At about 10:30 A.M. part of the roof collapsed; and a short time thereafter, the building floors fell in and parts of the walls fell out.

Nov. 26, Kennetcook, N. S., Hants North Rural High School $415,000

PUBLIC SCHOOL. This large rural school located 35 miles from the nearest fire department depended primarily on a 3,000-gallon-capacity pressure tank sprinkler system for its fire protection. This system would undoubtedly have extinguished the fire or would have held it in check until public fire protection arrived had it not been for the fact that it originated in an unsprinklered concealed space between the first and second floors where it burned for more than 1½ hours before the Windsor Fire Department reached the scene.

The building consisted of two adjoining and communicating sections, one noncombustible and the other, where the fire originated, combustible. (See photo, page 309.) Walls and ceilings in the combustible section consisted of combustible fiberboard on wood studs and joists with the exposed surfaces plastered.

The school janitor had been using a propane torch on pipes above a first-floor shower stall in the combustible section during the morning of November 26. By eliminating other possible fire causes, it is presumed that his torch ignited the hidden surface of the combustible fiberboard ceiling. While he was home at lunch the fire spread through concealed wall and ceiling spaces. Eventually it broke through the ceiling in several locations operating sprinklers which performed satisfactorily on fire within range of sprinkler discharge. However, sprinklers had no effect on fire spreading through concealed spaces and consequently the fire was still out of control when the water supply to sprinklers was used up.

The sprinkler waterflow alarm was noticed at 1:30 P.M. and the Windsor Fire Department was called. When two pumpers, a rescue squad and 16 fire fighters arrived 35 minutes later, fire had broken through the roof in one small area; and if there had been a readily available water supply, it is probable that part of the combustible section could have been saved. The two pumpers relayed water from a river 1,500 ft. away through a 2½-inch hose wyed into two 1½-inch hoses. The fire department was commended for being able to prevent the fire from spreading to the noncombustible section with these two small lines.

May 3, Chicago, Ill., Electro Lighting Corp. $966,000

ELECTRICAL APPLIANCES, ASSEMBLING. The plant involved in this fire was a 150 ft. by 600 ft. (2-acre), 1-, 2-, 3-, and 4-story mostly brick, wood-joisted and heavy timber building. Access to the building was limited to streets at both ends since high railroad embankments extended along the sides of the building. The completely sprinklered building was supplied from a city main through an eight-inch dead-end yard main servicing 13 sprinkler risers and two gravity tanks. The water pressure on the yard main was boosted by an electric-driven 750 gpm fire pump. The yard main which ran the length of and under the building was equipped with a fire department connection at both ends. Two sectional control valves divided the system into three major parts:

Part I — 8-inch city connection, meter on bypass and meter valves, fire pump, fire department connection, four risers, and two gravity tanks.

Part II — Sectional valve, and six risers.

Part III — Sectional valve, three risers, and a fire department connection. (This last fire department connection was located 100 ft. from a public double hydrant.)

A leak in the underground 8-inch yard main below the floor of the building was discovered on the fire pump side of the first sectional control valve (Part I).

The owner had his own men prepare the building for the repairs. They shut off the fire pump and one gravity tank, drained the other gravity tank, and broke up the concrete over the break. They then left the job to be finished in the morning by the sprinkler contractor.

No attempt was made to close the sectional control valve beyond the break (Part II) and back-feed the nine risers on the other side of this valve with two hose lines from the nearby public hydrant through the end fire department connection (Part III).

There was no attempt to provide back-feed to the four sprinkler risers (Part I) through their 2-inch drain valves. There was no attempt made at around-the-clock repairs. There was no attempt to provide watchmen, hoses and extinguishers for the areas of floors that now were without sprinkler protection.

When the fire broke out on the unoccupied second floor, there was no one to see it and no sprinkler system to put it out and give the alarm. With the delayed alarm and difficult access, the plant burned to the ground. In addition to the property damage there was an insured business interruption loss of over $387,500.

Feb. 20, Gatineau, P. Q., International Fibreboard Ltd., 2 killed $1,200,000

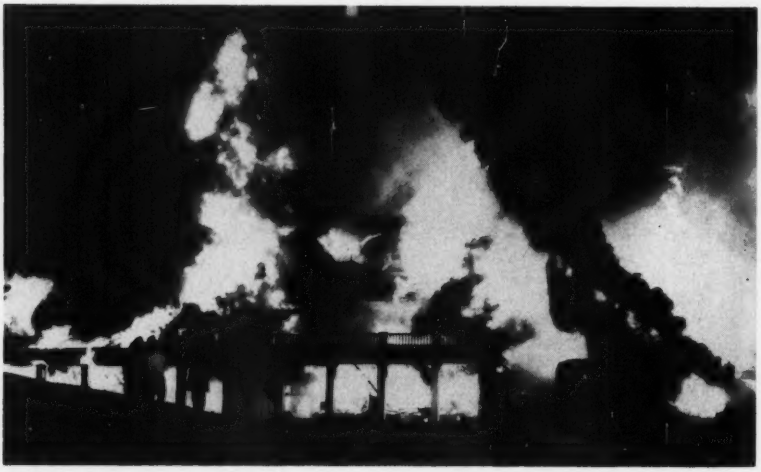
WOOD FIBER PRODUCTS PLANT. One leg of an L-shaped group of adjoining and communicating sprinklered buildings was destroyed by fire that originated in a storage area for finished fiberboard sheets wrapped in paper, six 4 ft. by 6 ft. sheets to the package. The storage area where the fire started was in one of two groups of buildings comprising one leg of the L. The groups were separated from each other by a division wall with protected openings and from the other leg of the L by a division wall with protected openings (see photo, page 321).

At 4 P.M., when a foreman came on duty, his nose told him something was hot and he checked the storage section then and several

times later until at 8:45 P.M. he saw smoke rising from a stack of fiberboard. As he sent a man to call the fire department and as he, himself, went to get a standpipe hose, flames became visible on the wrappings. They spread rapidly to another pile and leaped to the ceiling where there was a flash and a rumbling sound as fire spread rapidly beneath the roof. As the foreman ran through an opening in the division wall to the adjoining building there was a rush of air and empty cartons were blown into the adjoining building where he had escaped. Another employee who was bringing extinguishers could not get to one of three openings in the division wall before the door closed and although he eventually got out he suffered fatal burns. An employee who was driving a lift truck in the section of origin drove the vehicle toward a doorway in the division wall as flames spread over his head but abandoned the lift truck and sought to hide in the building of origin. He also suffered burns that eventually took his life.

The lift truck stopped in a doorway of the division wall, preventing the fire door from closing. Fire spread through the opening and on through the communicating group of buildings in the leg of the L but was prevented from spreading into the other leg by a division wall with protected openings at the junction of the two legs.

The storage building where the fire started was protected by a dry pipe sprinkler system containing standard spray type sprinklers. Other buildings were sprinklered, some by wet and some by dry systems. Reports indicate that there was enough water to supply all sprinklers in the building of origin simultaneously and that all valves were open. Although there is no agreed upon explanation for the inability of sprinklers to perform satisfactorily one possible explanation is



N. Verderosa

COUNTRY CLUB, Greenwich, Conn. At 3:58 A.M., Sept. 5, Labor Day morning, an occupant of an apartment in the Greenwich Country Club awoke to find smoke. He pulled the local fire alarm, which alerted the other 41 guests or residents and then telephoned the public fire department.

The municipal fire chief had recommended complete installation of automatic sprinklers when part of the club was modernized several years ago. However, sprinklers had been provided only in the boiler room and kitchen. Although the area where fire started was not definitely established, it is known that it was not in one of the sprinklered areas. The main building was destroyed and fire fighters used five 2½-inch and two 1½-inch hose streams to save an addition connected by a breezeway to the club building. Loss was $1,105,000.

Lost in the blaze was the club's historic Victoria Diamond Jubilee challenge cup. The cup was in a glass case cemented to the floor inside the front entrance. While management had thus taken steps to safeguard the trophy against theft, apparently the potential damage by fire had not been considered.

Nassau County Fire Marshal

HOTEL, Atlantic Beach, N. Y. The water tank on the roof that supplied sprinklers was either frozen or empty when fire broke out in the sprinklered penthouse of the Nautilus Hotel on March 14. See report below.

that the fire spread so rapidly through the buildings in the fire division of origin and also in the adjoining fire division that water supplies were quickly overtaxed.

Reason for the rapid spread of the fire is another point on which there is disagreement. One explanation was that wood fiber dust on structural members was thrown into suspension when the flames originally mushroomed beneath the roof creating a dust-laden atmosphere beneath the roof through which the flames spread. Had the lift truck not prevented a fire door from closing, investigators believe the fire would have been confined to the fire division of origin.

Cause of the fire was probably spontaneous heating of freshly made fiberboard which had been piled hot several hours earlier.

Mar. 14, Atlantic Beach, N. Y., Nautilus Hotel $2,800,000

HOTEL. While this apartment hotel was closed to business for the winter, fire broke out in an employee's room in the 2-story wooden penthouse atop the 7-story brick, wood-joisted building. At the time, all employees were in the first story having coffee. The penthouse and hallways of the seventh story were sprinklered but, as later determined, no water flowed from the sprinklers. This condition was either because the roof tank was frozen or was empty.

The fire was first noticed by three workmen three blocks from the building. They immediately telephoned the Inwood Fire Department at 8:53 A.M., then went to the hotel where they and the hotel employees took elevators to the top of the building. The sprinkler system was not operating nor was any water available from the standpipe system. On arrival fire fighters first tried to get a hose to the roof by means of an aerial ladder, but the ladder was too short. When a pumper was connected to the building standpipe system, water was available on the seventh floor, but by this time the fire was

beyond control in the penthouse and was spreading through the concealed space between the seventh-story ceiling and the roof. It soon became necessary to abandon fire fighting from the roof and before long, when the seventh story became involved, fire fighting from inside the building was discontinued.

Feb. 6, Paterson, N. J., Freetex Weaving Corp. $300,000

SYNTHETIC FIBERS. Although this property was protected for the most part by sprinklers, two raised platforms in the top story (comprising about one-quarter of the 6,200 sq. ft. area) did not have sprinklers under them. While cleaning a jacquard loom on the top floor of the 4-story building, an employee accidentally pulled the wires from the light fixture on an extension cord. Sparks ignited a cloth dust cover and fire spread rapidly in all directions, feeding on lint on structural members and machinery.

Fire extinguishers used by employees did not control the blaze but 28 sprinklers eventually operated to extinguish the fire except in areas below the unsprinklered decks. The shielded fire was put out with three fire department hose streams which delivered about as much water as the sprinklers already operating. Sprinklers were allowed to operate for an hour until it was certain that all fire was out. During this time thousands of gallons of water discharged into the fourth story, and most of it eventually found its way to lower floors where water damage to stock and machines was heavy. Had there been scuppers and floor drains, most of the water damage could have been avoided.

Private Water Supplies and Fire Pumps

In 261 of the 319 large loss building fires in 1960 there were no private water supplies or fire pumps. In 40 cases this lack of adequate private water supplies was a factor in the outcome of the fire. In 19 other fires the private water equipment available contributed to restricting the extent of the loss.

Fire Pump Failures

In 6 cases failure of fire pumps to operate properly was a factor in the fire. The 6 fire pumps failed for the following reasons: 3 pumps suffered power failure during the fire; one had been shut off a few hours previously for repairs to the underground; one was not operated during the fire; and in one fire two fire pumps suffered mechanical failures during operation.

Water Supply Failures

The 11 water supply failures were due in 5 cases to an inadequacy of the supply; in 4 cases to an insufficient number of yard hydrants; in one case a yard hydrant was frozen; and in one case the private water tank was empty.

May 20, Northampton, Mass., Northampton State Hospital $350,000

MENTAL INSTITUTION. One of three fires set in different hospital buildings on May 20 destroyed a large wooden barn containing farm machinery, hay, cattle and disinfecting chemicals. Twelve cattle were killed. It is fortunate that the fire did not involve a building housing patients since the fire brought to light a serious condition in the private fire main system that could have been responsible for a major loss of life disaster.

The 12-inch private fire main that served yard hydrants on the hospital grounds was supplied at one end from a 12-inch public main and at the other end from a 16-inch public main. At the 12-inch public main end of the yard main there was a 1,000 gpm centrifugal steam turbine-driven fire pump located on a bypass. Check valves were installed at both ends of the yard main to prevent water from re-entering the public mains. At least one of these check valves failed several years ago when, during a low pressure condition in the 12-inch public main, water flowed from the 16-inch main through the yard main, through the defective check valve, through the centrifugal pump (causing it to run backwards) and into the 12-inch public main. To stop this flow a post indicator valve at the 16-inch public-main-end of the yard main was closed. It was still closed when this fire occurred.

As no pump tests had been run recently, no one knew that the shaft of the pump had frozen in place. A valve in the yard main between the pump by-pass connections was also closed for an undetermined reason.

Arriving at the fire, fire fighters laid lines from a pumper with every expectation of confining the fire to one wing of the T-shaped barn only to discover that the water

available from the yard system was just that which could be sucked past the frozen pump impeller. It was not until after a 1-hour and 20-minute delay in starting the fire pump because of lack of steam that the frozen pump impeller was found. Three men using a 3-foot pipe wrench finally freed the shaft from the turbine to the pump, but by then the barn was beyond saving.

The closed valves were discovered later.

Fire Brigades

In the 268 large loss fires where there were no private fire brigades, this absence was a factor in the outcome of 47 fires. In 12 cases the fire brigades did all that could be expected. There were 7 cases where the fire brigade did not perform satisfactorily. Three of these were due to insufficient or defective equipment, 2 brigades were poorly trained, and in 2 cases the fire was too far advanced by the time the fire brigade went into action for it to be effective.

Standpipe and Hose Systems

In 234 of the building fires no standpipe systems were present. In 56 no data were available. Of the 29 buildings where standpipes were present, 7 systems were not a factor in the outcome of the fire as no one was present to operate the systems. Four systems were used to extinguish or assist in fire control.

Eighteen systems failed to operate or were operated improperly. In 5 instances the fire was too far advanced on discovery for the hose systems to be effective. In 5 cases the hose was located too far from the fire to be effective, in 4 cases there was a poor or inadequate water supply, in 2 cases an explosion prevented effective use of the hose, and in 1 case the hose was deteriorated. In 1 case insufficient details were available to explain the failure.

Sept. 6, Albany, N. Y., Wander Building $556,000

RESTAURANT. Summoned by an alarm from a street box at 8:11 P.M., fire fighters found a first-floor food shop heavily charged with smoke. The seat of the fire could not be located because of the smoky conditions and during this time fire spread up through toilet vent shafts to the attic of the 6,800-sq.-ft. 6-story unsprinklered mercantile and office building. Fire eventually broke through the roof.

Hose standpipes in the building of fire origin as well as in exposed property were charged by connections from fire department pumpers. Building hose in an adjoining theater that was attached to its standpipe, was run to the roof by fire fighters and streams directed at the involved office building. During the operation high pressures ruptured the hose in the theater, causing $10,000 water damage (there was no fire damage to the theater). Fire fighters then connected their own hose to the standpipe to continue this phase of extinguishing operations.

Portable Fire Extinguishers

Hundreds of fires are put out successfully with ease every year due to the proper use of properly charged and designed fire extinguishers.

In the 319 large loss building fires of 1960, only 11 occurred in buildings without portable fire extinguishers. There were no data on extinguishers in 30 cases. In 278 cases portable fire extinguishers were present. In 223 of these, fire extinguishers were not a factor, either because the buildings were unoccupied at the time of the fire, or because the extinguishers were not used for one reason or another. In 3 of the remaining 52 cases extinguishers performed their function satisfactorily.

In 49 cases the use of portable fire extinguishers was not successful in controlling the fires which ultimately resulted in large losses. Most frequently a combination of circumstances is responsible for such experience but the principal factors appear to be: (1) use of extinguishers of inadequate capacity (evident in 23 of the large loss fires); (2) use of the wrong type of extinguishers for the class of fire involved (true in

13 of the large loss fires); (3) fire too far advanced on discovery for effective control by extinguishers (11 cases); (4) extinguisher did not operate due to lack of maintenance in one case, and (5) fire spreading too fast for effective control in one case.

Dec. 30, Maryville, Mo., Townsend Wholesale Grocery Co. $250,000

FOOD PRODUCT STORAGE. Two extinguishers used by employees discovering fire did not operate because they had not been recharged since 1957. Since nobody called the fire department during the time attempts were made to quell the blaze, efforts by fire fighters to check spread were not successful and the property was a total loss.

Had employees investigated a peculiar odor about an hour before fire finally broke out, it is likely that the electrical fault in a second story control panel would have been confined to the panel.

Protection of Records

Throughout the year there were cases of serious loss of records. As an illustration see the article "Act II — The Indirect Losses" on page 297.

Record protection equipment was missing in 43 of the 319 building fires. Its absence was a factor in the loss of records in 24 of these cases. In 130 fires no data have been received on the presence or absence of record protection equipment. In 146 fires record protection equipment was present. In 102 fires it was not a factor in the saving of records.

In 36 cases it operated as designed to protect its contents.

In 8 cases it failed. Three of these failures were due to the use of record

H. Crowson

CHURCH, Sumter, S. C. The 1,316 members of the 47-year-old Trinity Methodist Church were confronted with the task of replacing their beautiful structure following its destruction by fire on June 10. In the absence of automatic fire protection the fire of unknown cause and origin burned undetected until seen by a newsboy at 5:30 A.M. "By the time we got to the scene," the fire chief said, "everything was burning." Not included in the $500,000 loss, one third of which was covered by insurance, were such intangible but very real losses as all the sermon notes of the church minister.

protection equipment inadequate for the exposure to be expected. In 2 cases valuable records were lost due to use of unlisted substandard containers. In the three remaining cases, 1 failed due to explosion damage of the container, and in 2 cases insufficient information was available for analysis.

Mar. 10, Gloucester City, N. J., Gloucester City Board of Education $303,000

PUBLIC SCHOOL. A defective control on the oil-fired heater was the cause of fire that eventually destroyed the unsprinklered 3-story brick, wood-joisted school and its contents, including all school records. On discovering the boiler room filled with smoke at 7:30 A.M., the janitor called the Superintendent of Schools to ask what to do. In the meantime a neighbor saw smoke and called the fire department. The nonfire-resistive and not-cut-off boiler room was in flames when firemen arrived. Fire spread to the rest of the building through hot air ducts and open stairways.

Included in the loss were all school records. Also destroyed was the steeple of a church on adjoining property.

Mar. 12, Calgary, Alta., Alsco Ltd. of Canada $275,000

ALUMINUM FABRICATING (Storm doors and windows). Records in paper box files and in noninsulated file cabinets were destroyed by this fire. The fire started sometime after the 50 ft. by 210 ft. unsprinklered building was closed for the work day and after the janitor-watchman had finished cleaning up (about 7:30 P.M.). The watchman patrolled the outside of the building only, at intervals several hours apart. On his second round of the night (5 A.M.), looking into the office window he saw nothing, but on moving away he heard loud shooting-type noises and saw smoke; he immediately called the fire department from a nearby phone and then notified the plant owners.

Responding fire fighters found the building entirely involved, as flames had spread rapidly across the asphalt-paper backed insulation. As there were no automatic sprinklers, the damage to the steel-framed, cement-asbestos-covered wall building was severe; production of the aluminum storm window and doors was totally stopped. The owners expressed the hope of moving to a new sprinklered location before resuming business.

Summary

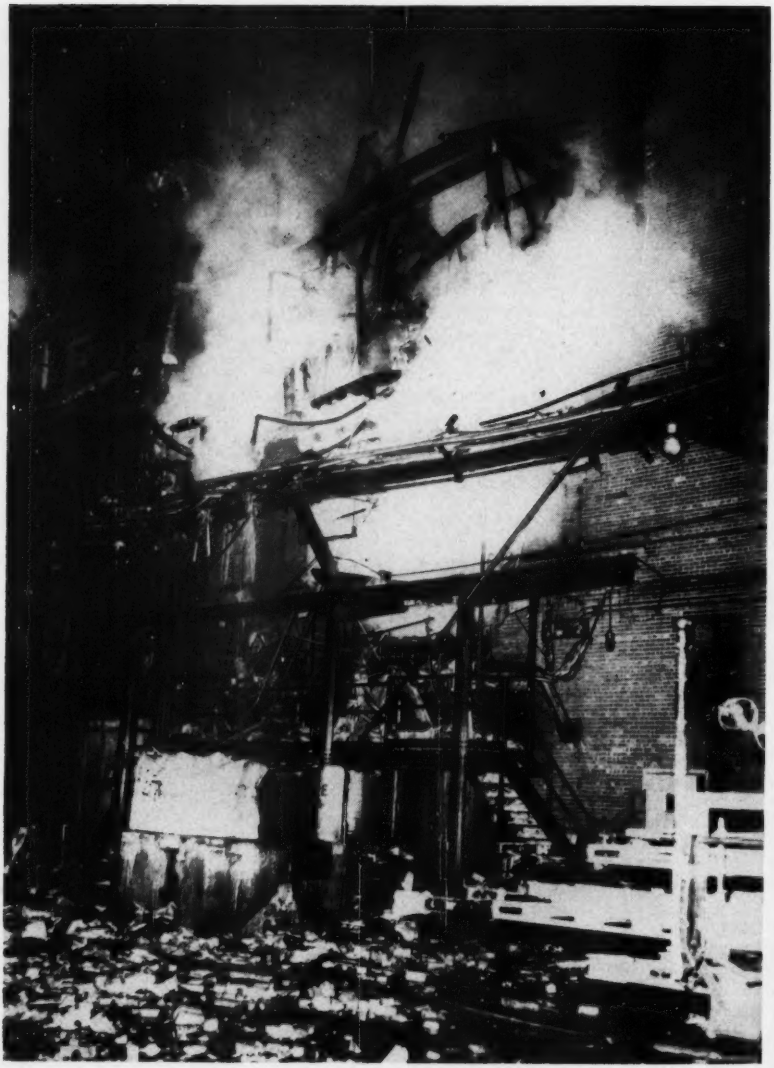
The foregoing examples should make quite clear the point that merely the provision of private fire protection equipment is not adequate to prevent large loss fires. The proper maintenance and operation of this equipment are necessary corollaries.

Looking at these cases of fire equipment failures should not obscure the fact that thousands of fires are successfully extinguished by sprinklers, by extinguishers, by hose systems and by fire brigades. The danger of not providing this equipment is emphasized below.

Nov. 12, New Sharon, Maine, Medomak Canning Co. $1,000,000

CANNERY. This canning company employed 85 to 200 of the 707 local residents of this small New England town. The company thus provided about seven-eighths of the total town payroll. This bulwark of the town's economy was protected only by a 500 gpm pump supplying a six-inch main to a private fire hydrant. The pump was a substandard belt-driven vertical unit. There was no sprinkler system, no detection system, and no watchman.

At 4:45 A.M. a neighbor saw the flames coming from the plant area. He phoned the fire department which immediately called for additional help. The control panel for the pump motors was in the flames so that no power was available to operate the pump. It really didn't matter much for on arrival the fire department found the plant well involved.



Cliff Preisight

OTHER CHEMICAL PLANT (Dyes, other organic chemicals), Buffalo, N. Y. An unexplained rupture of a reactor containing methanol and other chemicals released the flammable mixture in the third story of this chemical plant on Aug. 30. The vaporizing methanol ignited causing a severe explosion at 11:24 P.M. The sprinkler system, which operated over a wide area on 2 floors, was shut off and extinguishment completed by hose lines.

One man was burned to death and two others were seriously burned in the $800,000 blast and fire.

1960 Large Loss Building Fires—

Time, Place, and Origin of Fire

Time of origin has an influence on the large loss experience. A recent review of fire department annual reports showed 58 per cent of alarms for all fires occurring in the twelve-hour period between 6 A.M. and 6 P.M. and 42 per cent for the other 12 hours. The study of large loss fires reverses this picture since 60 per cent occur during the night (the 6 P.M. to 6 A.M. period).

The lightest period for all types of fire alarms noted in the previously mentioned review was between 3 A.M. and 6 A.M. when only 4.4 per cent of the alarms were received. Conversely, the 3 A.M. to 6 A.M. period was the heaviest 3-hour period for large loss fires, as 16.8 per cent of the fires were discovered between these hours.

These reversals show clearly the influence of delayed discovery (see article on Detection of Fire) and occasionally the effect of nefarious nighttime operations, such as burglary and arson.

Place

The physical size of the town involved, its population and its total wealth seem to have little to do with the large loss experience. The factor that appears to be important is the frequency with which large values are exposed to fire without adequate fire protection. (See article on Private Fire Protection.) As long as such values are left unprotected and exposed, there will be large loss fires.

Origin

Multistoried buildings were the scene of 167 large loss fires. Seventy-three of these were in multistoried buildings without basements, 94 in multistoried buildings with basements. The remaining 152 large loss building fires occurred in 1-story buildings, only 28 of which had basements.

Floor of Origin

One hundred and eighty-one large loss fires started on the ground floor, 52 on the upper floors, 39 in basements, 17 in the attic, 9 on the roof, 7 in spaces under the building and 5 fires spread inside from the outside. The remainder started in unknown areas of the buildings. For information on how these fires spread see pages 305 to 326.

Feb. 7, Ridgefield, N. J., Public Service Electric and Gas Co. $3,155,000

ELECTRIC GENERATING PLANT. When the gas burners in the furnaces of one of the main boilers were being relighted after a shutdown for repairs, a representative of the boiler manufacturer was present. During a shift change of operating personnel, the manufacturer's representative discovered one of the burners out, shut it off, and reported to the watch engineer. The control panel did not indicate that the burner was out.

Men were sent to check several other burners in the same boiler and found two others out. Before they could report back there were two explosions in the furnace. There was no fire and no fatal injury. The boiler burners were not provided with automatic flame supervision or combustion safeguards. Several such devices had been tried at this plant but none had been found entirely satisfactory.

Mar. 3, Waukegan, Ill., Johns-Manville Corp. $1,750,000

ASPHALT ROOFING PLANT. Close to 1½ of the four acres covered by the 1-story, brick, plank on steel building at this plant was destroyed by fire that started at 3:50 P.M.

A flash fire, like many others, occurred in a spray type saturator. The saturator's automatic deluge system extinguished the fire, it was thought. But when the deluge system was shut down and the cleanup started there was a re-flash of large proportions. The flames prevented anyone from reaching the deluge valve manual controls located too near the saturator. It is reported that the building sprinklers had also operated at the earlier fire and had also been shut off. In any case, fire had spread unchecked through most of the building before it was extinguished. All four saturators in the building were out of service for some time, creating an insured indirect loss of approximately $1,000,000.

May 25, near Bunkie, La., Guaranty Seed Co. $435,000

FERTILIZER MIXING PLANT. At about 2:00 A.M. a fire of undetermined origin broke out in a 1- and 2-story metalclad, wood-joisted fertilizer manufacturing building. A night watchman for another plant discovered the blaze after it was well established and visible outside the building. A single 750-gpm pumper responded and was able to protect surrounding structures.

1960

Dec. 7, Robins Air Force Base, Ga., United States Government Repair Shop $1,116,000

GENERAL LABORATORY. Automatic sprinkler protection was being installed in this noncombustible 200 ft. by 200 ft. 1-story building with wood roof. The system was 50–75 per cent complete.

Oil for hydraulic component test equipment was heated by a single thermostat-controlled heater. When the thermostat failed, after the building had been closed for the night, the oil overheated releasing volatile vapors. These vapors were ignited from an unknown source. The unsprinklered 1-story building was destroyed.

May 6, Derry, N.H., Chelmsford Shoe Company, Inc., et al. $972,000

SHOE MANUFACTURING (Conflagration). A cigarette was thought to have been the cause of this conflagration. At 4:00 P.M. most of the 350 employees had left the 3-story wooden factory. Five minutes later a woman waiting for her husband about 150 feet away from the plant noticed a carton burning on a small open wooden platform next to the building. This platform was used for the storage of wastepaper and empty 55-gallon solvent and cement drums. She called to her husband as he crossed the lot toward her to kick the burning carton out of the pile. As he approached the platform one of the drums exploded. The fire then mushroomed across and up the outside of the building. As the windows of the upper two floors were open the flames swept into the building here. The fire opened so many sprinklers that the water supply was severely taxed and the sprinklers were ineffective.

Responding fire fighters connected two hose lines to the hydrant across the street and opened the hydrant. Before the lines were fully charged the heat burned through the hoses and drove the men back so that the hydrant could not be closed, and this further weakened the water supply.

One of the first exposed buildings to ignite and the only one to ignite from flaming embers was a wood shingle roofed dwelling approximately three hundred feet away. Radiated heat ignited 12 other apartment and dwelling buildings (closest 50 feet away) as the fire jumped streets and spread a total of 300 feet in two directions.

United Press International

The Derry, N. H., Conflagration.

1960 Large Loss Building Fires—

Detection of Fire

Detection of fire is the first step in the fire control operation. Detection can occur in a variety of ways, but in order for the alarm to be given someone or something must detect the fire. Ideally, detection should occur simultaneously with ignition of the fire.

Of the 319 large loss building fires, 31 per cent (99) were detected promptly. Delayed detection was a factor in the other 69 per cent (220).

Detection Record

The initial detection of the fire was made in 131 cases by occupants or employees, in 112 by outsiders or passers-by, in 22 by watchmen, in 17 by an explosion, in 17 by police, in 9 by automatic fire alarm equipment, in 3 by a burglar alarm, and in 3 by automatic sprinklers. In 5 fires, means of detection was not given.

Operating Status

Of the 319 large loss building fires in 1960, 183 occurred when the building was not occupied or occupied only by watchmen or janitors. Discovery was delayed in 89.6 per cent (164) of the fires in these buildings. Eighty-seven fires occurred in buildings which were fully occupied (shifts working, classrooms full, etc.). In these 87 fires discovery was delayed in 26.4 per cent (23).

Forty-nine buildings were occupied partially (maintenance crew or office staff on hand). In 67.3 per cent (33) discovery was delayed.

Carl R. Oliver

FRATERNITY HOUSE, Stanford, Calif. On August 23, during a short vacation period when the Phi Gamma Delta house was unoccupied, an unknown person used a flammable liquid to start a $250,000 fire at the base of the main stairway of the unsprinklered building. The fire burned for more than an hour before nearby residents heard a beam fall and investigated.

SHOPPING CENTER, near Stockton, Calif., $280,000 (above). SUPERMARKET, Los Angeles, Calif., $550,000 (below). Occupancy or attendance of property during operating or working hours does not assure that fire discovery will be prompt. Even though there were clerks and customers in each of these retail stores, fires were well established before being seen by occupants. Fire fighters found both buildings heavily involved by smoke and fire upon their arrival.

Los Angeles Times

June 25, Lowell, Mass. Rex Amusement Center $827,500

AMUSEMENT AND RECREATION PLACE (Bowling Alleys). Without watchmen, chance discovery of fire here depended on occupants or passers-by and the circumstances surrounding this total loss shows again that fire often reaches serious proportions before occupants are aware of it — even in daytime periods. A special policeman on duty in a nearby parking area saw smoke coming from around windows at 10:50 A.M., some 10–15 minutes after workers in a first-floor office noticed that lights were "flickering." Despite prompt response by the public department to 4 alarms and use of many large hose streams by 15 mutual aid departments, damage during the 4-hour fire to the restaurant, 65 bowling alleys and pool rooms was practically total. Extensive efforts were required to prevent spread to exposed property, connected in one direction by a bridge at second-story level.

The building of origin and neighboring exposed buildings were formerly occupied by a cotton spinning mill. Automatic sprinklers were not restored to service following remodeling of the buildings about 25 years ago, at which time the 5- and 6-story buildings were reduced in size to 2- and 3-story, and basement.

Investigation by the state fire marshal's office showed that fire apparently was started behind combustible wall sheathing in the basement by faulty electric wiring. Bowling alleys in the basement of the freely communicating L-shaped buildings were being refinished prior to annual summer shut-down and unknown quantities of flammable finishes, including some with lacquer base, are believed to have been a factor in rapid extension. Work had stopped the previous day and it is reported that nobody had been in the basement prior to the fire on Saturday.

Lack of Detection Means

Lack of any private fire protection devices or services designed to assure prompt fire detection was by far the largest factor in the delayed discovery of fire. In 82.7 per cent (182) of the 220 cases of delayed discovery, there was no provision for private detection in the form of automatic sprinkler systems, automatic fire detection systems, or watchmen.

Jan. 30, Kelsey, Man., Manitoba Hydro Board $1,000,000

BUILDING UNDER CONSTRUCTION. Although two men (whose jobs were to fill oil-fired heaters) saw sparks falling on a pile of scrap lumber from the overhead welding operations in the top story, they did not report or otherwise object to the unsafe practice because the same condition had been observed before. In fact, one of the men had put out a similar type of fire under exactly the same circumstances earlier in the construction of this hydro-electric generating station.

This fire developed on the main (top) floor of the 3-story building about 9:30 A.M. while both men were outdoors getting oil for the heaters. They discovered fire when returning with full oil cans and tried without success to put it out with extinguishers.

The building was generally of noncombustible construction, walls being constructed of ⅜-inch corrugated asbestos board sheathing having 1½-inch adhesive bonded glass fiber insulation and with ⅜-inch-thick asbestos board on the inside. The roof deck was corrugated metal having a fire retardant vapor barrier, affixed by an asphalt adhesive, over which were layers of cork and roofing felt.

Fire in the scrap lumber spread to plywood construction shanties, wood timbers and forms set up to support concrete to be poured for the scroll case roof at generator No. 5. It also involved combustible components of the roof and walls. Materials stored on the roof were ignited by heat and burning roof cement. There was a total of five carloads of lumber being used for forms in the area of fire origin. Four generators had been installed with the No. 5 unit, the last to go into this station.

All fire fighting was by employees and four hose lines were used for 3½ hours before they were able to get back into the 70-ft. by 475-ft. building. The fire was considered extinguished at 3:00 P.M. All walls and the roof of the station, while standing, were damaged beyond repair; but the generators already installed and some equipment on the lower levels received little or no damage.

Sept. 7, Waterbury, Conn., Second Congregational Church $760,000

CHURCH. This fire is one of the three large loss church fires of 1960 that were deliberately set. On Nov. 15, 1960, a 41-year-

old man was convicted of setting this fire in the basement of the 2-story brownstone, wood-joisted building. In the absence of automatic sprinkler protection the fire burned for 1½ to 2 hours until discovered by a patrolman at 1:32 A.M. By then it was spreading up an open stairway and within nonfirestopped walls.

Dec. 12, Eddystone, Pa., Eddystone Grade and High School $650,000

PUBLIC SCHOOL. Times at which electric clocks stopped indicated that the fire which eventually destroyed this 2-story brick, wood-joisted building had been in progress about 2½ hours before a passer-by saw smoke and gave the alarm at 7:40 A.M. Several residents in the neighborhood recalled smelling smoke at about 6:00 A.M. but after checking their houses gave it no further thought.

As later determined by investigation the fire originated in a first-floor classroom located directly over the heater room. It spread to other parts of the building via heating ducts that were not equipped with automatic dampers and mushroomed through a continuous 18-inch-deep concealed space between the roof and the ceilings of second-story classrooms.

The delayed discovery due to absence of a supervised automatic sprinkler system or

Wide World

PUBLIC SCHOOL, York Township, Ont. On Feb. 16, two suspicious fires originated simultaneously in small rooms at each end of the third-floor auditorium in the 3-story brick, wood-joisted Rawlinson Public School. With no automatic sprinklers to control and extinguish the fires, they burned undetected until they burned out of the rooms in the third floor and spread into the concealed attic space. A neighbor going to work spotted the flames and telephoned the alarm at 5:47 A.M. Loss was $325,000.

supervised automatic fire alarm system and the presence of the nonfirestopped concealed spaces explain why flames burst through the roof as the first fire company arrived.

Frank Jones

PUBLIC SCHOOL, Winston-Salem, N. C. Fires were set in at least three places in the 3-story brick, wood-joisted Fairview Elementary School on Dec. 1. One was set at the bottom of a stairway and at least two in desks on the second floor. In the absence of automatic fire protection devices the fires developed undetected until seen by a passer-by at 9:34 P.M. Loss was $400,000.

Watchman

There were 96 large loss fires in buildings having watchman service. In 10 of these cases the service was satisfactory since the watchman discovered the fire and transmitted the alarm with no delay. In 56 fires the watchman service was not a factor as the fire was discovered promptly by other means, such as by occupants (41), by explosions (10) an outsider or passer-by, and by (5).

In 30 fires the watchman service did not function effectively to provide prompt detection. In 13 of these cases the watchmen did discover the fire, but not until after an appreciable delay, while the remaining 17 were not discovered by the watchmen but by other means. It is interesting to note that 7 of these failures occurred in buildings which were protected by watchmen making standard hourly rounds. The 23 remaining cases involved substandard watchman service.

The reasons for this unsatisfactory experience are as follows: In 24 buildings (7 with standard watchman service) the fire broke out between rounds, in 3 cases the watchmen patrolled the outside of the building only; in one case each, he was asleep, he was not yet on duty though the plant had closed, and he went home to eat.

Dec. 1, Guntown, Miss., Comfort Furniture Co. $340,000

UPHOLSTERING PLANT. Fire broke out among cushioning material in the upholstering room of this unsprinklered, 1-story brick, wood-joisted building and burned for a short time before being discovered by the night watchman. This watchman was employed by other plants in the town, making his rounds in each at irregular intervals. Thus it was that he was not on the premises when this fire first began.

The only water available was that supplied by the fire equipment and in spite of repeated trips to refill the small tanks the damage amounted to a total loss.

Mar. 1, Edmonton, Alta., Canadian Bakeries, Ltd. $331,500

BAKERY. A doughman was given the responsibility of acting as a trained watchman for this 50 ft. by 150 ft. 2-story bakery. On his first round he smelled smoke. Unable to find its source, he continued on his round and went back to work. On his next round, 1½ hours later, he found smoke and fire. With this delay the fire, once out of the walls and in the open, spread rapidly throughout the structure.

Mar. 3, Port Graham, Alaska, Fidalgo Island Packing Co. $600,000

CANNERY. Because drifted snow covered the walkway to a pier, the watchman of this cannery building was forced to leave the building open to the public for their access to the pier. The watchman left the building

one afternoon for a brief period to enjoy the goings-on on the pier. On his return, he found smoke pouring out of one of the rooms and was able to escape only by crawling out on his hands and knees. The cannery was destroyed.

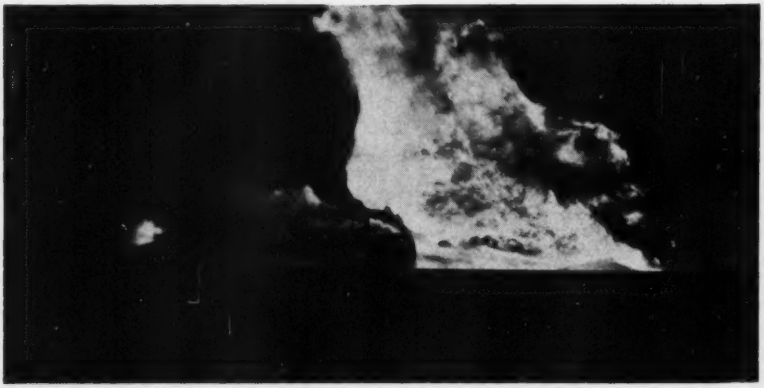
Sept. 16, Fall River, Mass., Made Rite Potato Chip Co., Inc. $280,500

Normand A. Fontaine

POTATO CHIP PLANT. A truck was left loaded with trash at an inside loading dock overnight. Shortly before 1:00 A.M. a fire was discovered by the night watchman. The flames had spread from the truck through unprotected openings to involve much of the unsprinklered building. Before fire fighting operations could be set up most of the damage had been done.

Automatic Detection Equipment

Automatic detection equipment was installed in 10 of the properties included in the 1960 large loss building fire record. Five systems were central-station supervised, 3 were auxiliary systems (connected to the fire department), 1 was a remote station system (connected to telephone answering service) and in 1 case no data were available on type of system. In only 3 of these 10 fires was detection delayed. One central-station system gave an open line instead of fire signal and was not promptly investigated. One auxiliary system gave a slow alarm due to inadequate thermo-



Boise Fire Department

SUPERMARKET, Boise, Idaho. Before apparatus arrived at the Albertson Supermarket from the nearest fire station several blocks away, an explosion had blown out one of the walls of this masonry, wood-joisted supermarket. Although the 1:08 A.M. alarm was received from a municipal fire alarm box connected to the automatic fire detection system, there apparently was a build-up of heated smoke and gases which caused the explosion soon after the alarm was activated. Fire had spread through the entire undivided attic and was coming from the rear of the first story when the fire department pulled up at the building. It was estimated that business could not be resumed for 5 months, the resulting loss of profit adding to the $448,500 property damage loss.

Las Vegas Sun

NIGHT CLUB, near Las Vegas, Nev. Despite standard watchman service with hourly watch rounds and prompt transmission of the alarm over the direct line to a fire station, structural deficiencies and contents features nullified efforts of the public fire department to check this June 17 fire in the main building of El Rancho Vegas before it was completely destroyed. Loss was $1,060,000.

The fire of undetermined cause apparently started backstage in the theater section. As soon as smoke was detected the alarm was transmitted by the watchman; but the undivided attic of the 29,000-sq.-ft. unsprinklered building, the wood shake roof covering and large quantities of alcoholic beverages stored in the building accelerated spread of fire to the extent that it was out of control when the fire department arrived.

Also located in the structure were a casino, cocktail lounge and restaurant. About 25 employees, show people and customers fled from the building without injury at 4:50 A.M. Guest cottages about 150 ft. away were not damaged.

stat coverage and the remote station gave a slow alarm which investigators failed to explain.

In the seven instances where automatic detection systems performed satisfactorily the fires became large losses for the following reasons: 3 because of rapid fire spread, 2 because the fire was inaccessible to fire fighters, 1 because of a fire gas explosion at time of detection and 1 because of smoke damage to food.

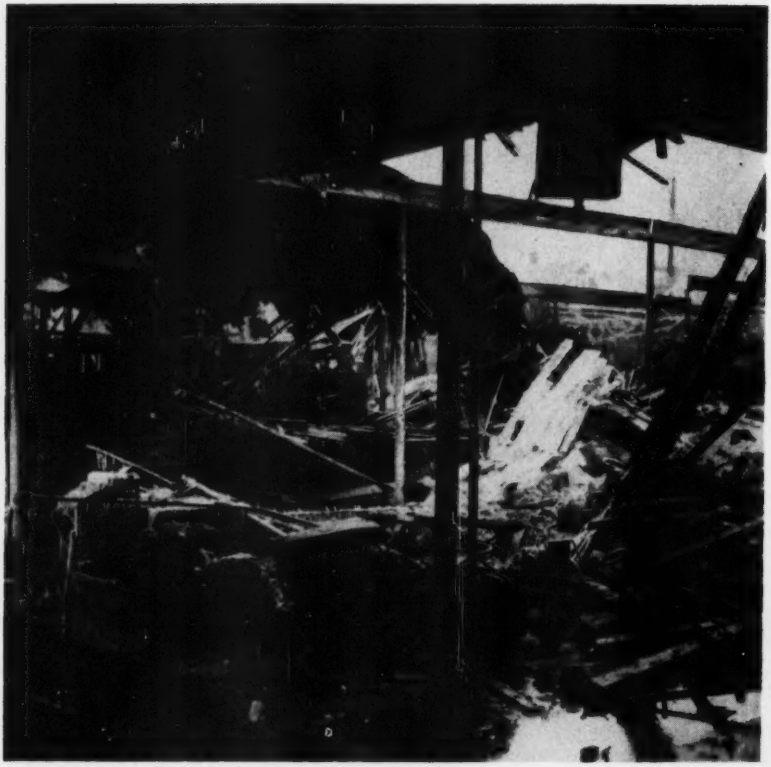
In addition to the fires first discovered by automatic fire detection systems, there were 5 cases where discovery was by automatic sprinklers.

June 7, Ellenville, N. Y., Sunrise Manor $375,000

HOTEL. Fire originating at the telephone switchboard in the lobby operated a rate-of-rise type fire detection system installed in the building. The local alarm aroused the two employees asleep in the building in time to escape, but they were not the ones to alert the fire department since a neighbor had already seen the fire and had telephoned the alarm at 1:56 A.M.

Arriving about 15 minutes later, the Ellenville Fire Department (one 750-gpm pumper, one 250-gpm pumper and 30 men) found the unsprinklered 3-story wooden building well involved, so concentrated on saving exposed cottages, some of which were occupied by hotel guests.

About 30 hours before the fire, during a severe lightning storm, the hotel switchboard lit up completely. A few hours later the hotel owner's wife smelled smoke. After a thorough search of the building, the smoke was attributed to cigars. Whether the disturbance at the switchboard during the storm was responsible for the fire that



Minneapolis Star

HEAVY EQUIPMENT SALES (Farm Implement Sales), Minneapolis, Minn. The central-station-supervised automatic detection system promptly gave the alarm of fire in this Sears, Roebuck & Co., store at 1:38 A.M., March 2. However, by the time the fire department arrived, the building was entirely involved. Mild explosions caused by cans of paint created a flash fire which required use of 25 hose streams of various sizes by a 4-alarm response before being brought under control. Damage to the building and the farm equipment it contained was $275,000.

was discovered 30 hours later could not be determined.

Oct. 12, Golden Valley, Minn., Margo-Kraft Distributors $790,000

PLASTIC, PLASTIC PRODUCTS STORAGE (Toy storage). The automatic fire detection system at this mostly 1-story and basement 152 ft. by 200 ft. warehouse was connected to a telephone answering service in nearby Minneapolis. Half of the unsprinklered building was heavily involved by fire when first apparatus arrived in response to the 1:29 A.M. alarm.

Toys were packaged in cardboard cartons piled to the underside of roof supports. This fact and presence of pressurized lacquer containers and model airplane cement contributed to rapid burning that resulted in a total loss.

Alarm of Fire

The alarm of fire is the second step in the fire control operation. Just as detection should immediately follow ignition, so should the alarm instantly follow detection.

Of the 319 large loss building fires an immediate alarm was given for 229. There was no fire department in nine cases. The alarm was delayed in the remaining 81 cases (25.4 per cent).

Alarm vs. Detection

The terms "delayed detection" and "delayed alarm" need not cause confusion. Prompt detection of a fire does not necessarily mean that the alarm to the fire department will be sent promptly. A study of the 81 cases of delayed alarm revealed that in 52 cases it was in addition to delayed detection, but in 29 cases it was an unnecessary delay to an otherwise prompt detection. The previous discussion of detection noted 220 fires where detection was delayed. Thus in 249 (78.2 per cent) of the large loss fires in buildings there was either delayed detection, delayed alarm or both.

Alarm Means

The initial alarm of fire was made by telephone in 215 cases, by street-mounted fire alarm box in 37 cases, by radio in 14 cases (police — 11, taxicab — 2, and fire — 1), verbal alarm at the fire headquarters in 11 instances, by private fire alarm box in 8 cases, by automatic fire alarm equipment in 8 cases, by private siren in 3 cases, and by automatic sprinkler equipment in 2 cases. The remaining 12 alarms were given by miscellaneous methods.

Alarm Delays

Occupants Fighting Fires

The most frequent reason for the 81 delayed alarms was the occupant who chose to fight the fire rather than give the alarm, thereby delaying the arrival of fire fighters. There were 34 such cases among the 1960 large building fires. Three of these occupants were watchmen.

Delayed Telephone Alarms

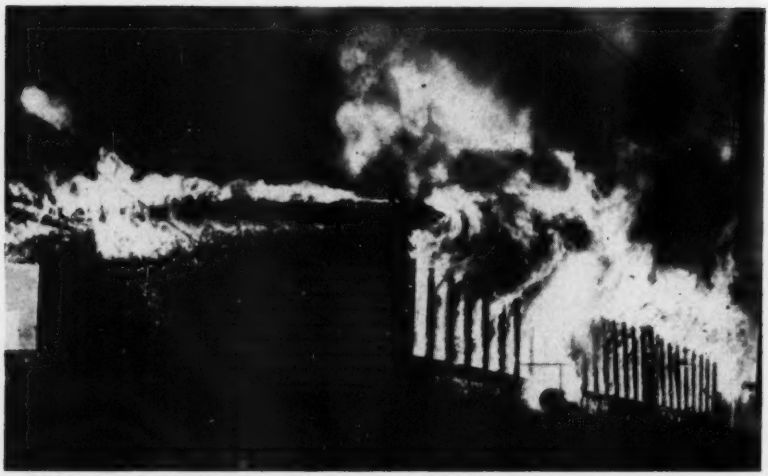
Of the 81 delayed alarms, 23 were due to difficulty with telephoning. In 10 of these 23 fires the alarm was delayed because the telephone was inaccessible, in 7 cases the discoverers called the wrong party, in 4 the telephone wires had burned in the fire, and in 2 there were no telephones available.

Other Delayed Alarms

Of the remaining 24 cases of delayed alarms, occupants who investigated first (6), and bystanders who failed to call the fire department (3), were the principal reasons.

Nov. 7, Gary, Ind., Shoppers Fair of Indiana, Inc. $995,000

Appliance Sales. Twenty minutes after this discount house closed at 10:00 P.M., and before it was locked up for the night, the assistant manager and a policeman made a final check of the premises. At 10:33 P.M. a burglar alarm signal was received at police headquarters and a patrol car was dispatched by radio. After finding doors secure, the officer returned to his car, at which time windows in the only wall having openings blew out. Responding to the officer's radioed alarm, fire fighters found fire spreading rapidly through the undivided 1-story



The Empire World

PUBLIC SCHOOL, Empire, Oreg. Two 14-year-old boys set a fire in the boys' toilet room of this 1-story wooden elementary school. When smoke started to spread through the 14-room in-session school, the building fire alarm was rung. Within 30 seconds the 408 pupils had left the building. Fire drills in which smoke bombs and blocked exits had been used were probably responsible for the rapid orderly evacuation through smoky corridors. Pupils and teachers were unaware that this Feb. 17 fire was real until they arrived safely outside.

building. The fire had originated in a congested stock storage area separated from the sales area by a combustible partition. Hose lines 1,200 ft. long, supplied by relay pumping, were required in extinguishing the 6-hour fire in the unsprinklered property.

Employees had smelled smoke for a week and on the evening of the fire, an odor of smoke was reported to the assistant manager. This large loss attests to the imprudence of not calling the fire department when the first trace of smoke is detected. Structural steel supporting the 59,911 sq. ft. noncombustible roof collapsed during the fire, greatly endangering firemen.

Nov. 7, Toronto, Ont., Loblaw Groceterias, Ltd. 1 killed, $567,000

SELF-SERVICE FOOD STORE. It is estimated that fire starting in a basement storeroom had burned for 15 minutes before discovery. Fire department notification was further delayed as employees used 3 extinguishers before telephoning for help. One fire fighter was killed and the property was completely destroyed before fire in the 9,000-sq.-ft. 1-story and basement store was extinguished.

Automatic sprinklers were being installed but the system was not far enough along to place in service.

Dec. 28, Newark, N. J., Stephen-Leedom Carpet Co. $1,200,000

TEXTILE STORAGE. When a fork lift operator and his helper were in the second story removing a roll of carpet, the helper noticed flames coming from the center of the pile. Attempts were made by both men to put out the fire with one or more 2½-gallon soda-acid extinguishers, but flames spread across lint on burlap covering the rolls of carpet before the first extinguisher was emptied. At this point both men left the building and the fire department was called by telephone and by tripping of a street box.

Had the alarm been given promptly, it is likely that the first arriving fire fighters could have operated effectively in the area of fire origin. Heavy smoke meeting them when they did arrive forced use of smoke masks. Twelve hose streams were required at the height of the 5-hour battle to control and extinguish the fire.

Ben O. Bracken

AUTOS, FARM AND ROAD MACHINERY STORAGE, near Camden, Ark. The telephoned alarm for a fire in the Berg Warehouse was made as soon as possible following the discovery of the blaze by a passer-by. However, the discovery had been delayed as neither automatic sprinklers nor automatic fire detection systems had been provided. When the fire department arrived the building was completely involved. The fire occurred on April 7.

There was relatively light fire damage to the unsprinklered 3-story, reinforced concrete building, consisting of some spalling, smoke stain and damage to wiring. However, about 2,300 rolls of carpet on the first and second floors were damaged by fire and water from hoses. Absence of skids in some areas, and damaged slatted platforms in other sections permitted even greater water damage.

Plans for restoring the property call for installation of automatic sprinklers, including protection of intermediate levels of multitier woods racks for rug storage. Although cause of fire was not definitely established, it is believed that carelessly discarded

Ralph Bower-Vancouver Sun

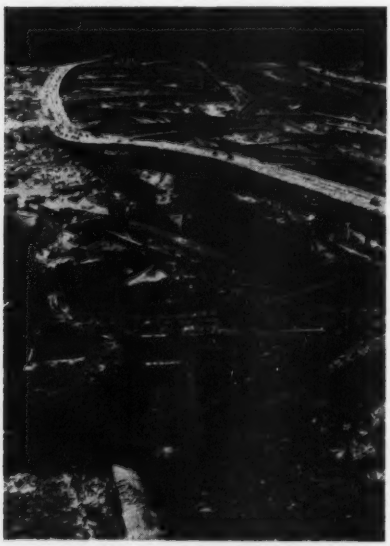
ARMORY, Vancouver, B. C. Discovering smoke coming from one end of the Stanley Park Armoury at about 4:00 A.M., Mar. 18, a street sweeper operator ran to an apartment building in an attempt to arouse the occupants and telephone an alarm. Failing in this effort, he ran toward a fire alarm box at a nearby intersection just as it was being pulled by a motorist. Returning to the building he watched the fire spread through the 1-story wooden building. The few minutes' delayed alarm was not as important here as the long delayed discovery in the unoccupied and unprotected building.

smoking materials were the probable source of ignition.

Dec. 17, Louisville, Ky., Parkmoor Recreation Center 3 killed, $760,000

AMUSEMENT AND RECREATION PLACE. When grease under a kitchen exhaust hood caught fire, employees tried to extinguish the blaze for an undetermined period before calling the public fire department at 7:26 P.M. Even though fire fighters arrived about two minutes after the alarm was finally given, the delayed alarm gave fire time to spread through ducts to the attic over the 1-story kitchen section. Flames also entered a communicating concealed space between floors of the 2-story part of the building. Small gratings had been installed in the second-story ceiling so that cigarette smoke could be cleared. These openings afforded a way for fire to get into the attic over the 2-story section.

The entire 44,132 sq. ft. unsprinklered recreation center was destroyed in the $760,000 fire. Three fire fighters were killed when a first-floor ceiling collapsed and released a wave of superheated air and toxic gases. Three others were injured during extinguishing operations.



Louisville Courier-Journal

Sept. 26, Beacon, N. Y., Dorrell Hat Co. $330,000

HAT MANUFACTURING. Although the 3-story brick, wood-joisted building was sprinklered, a water flow alarm had never been provided and watch service during idle periods was discontinued in 1948. When fire started in the top story sometime after 5 P.M. quitting time the previous day, three sprinklers at the roof operated to extinguish it. However, water discharging from the three sprinklers was not detected, because of the lack of any water flow alarm, until 3:45 A.M. when an employee arrived to start the boilers.

The uninterrupted flow of water for 6 to 8 hours damaged stock on all floors but fire damage was only $500. Had sprinkler protection not been provided, it is probable that fire would have destroyed the plant.

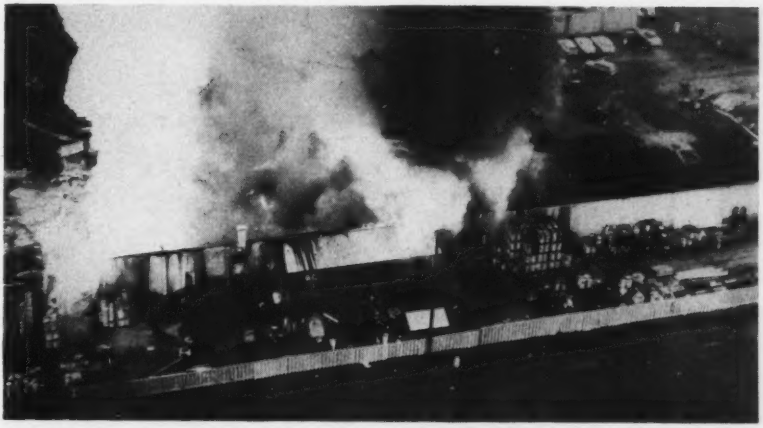
Jan. 31, near Albany, Oreg., Oregon Metallurgical Corp. 2 killed, $384,500

OTHER METALS, REFINING AND SMELTING (Vanadium refining). Vanadium metal was being produced in the Research and Development Department of this plant by igniting a mixture of vanadium pentoxide, sulfur and calcium in a pressure vessel. Premixing had been done by hand in small batches but due to the need for greater production a modified mechanical feed mixer had been set up to handle about 350 pounds at one time.

This fatal fire occurred when the new mixer was being used for the first time. As soon as the mixer was started a scraping noise was heard. The mixer was stopped and shortly thereafter glowing particles of the charge were noticed near the bottom of the mixer. The foreman ordered his 6-man crew from the building, remained long enough to discharge a 20-pound carbon dioxide extinguisher at the glowing material, then ran to another building to telephone the fire department.

During the foreman's absence his crew re-entered the 1-story building to fight the fire. They soon decided they had better leave, but before they all could reach the outside a violent reaction developed in the mixer generating intense heat that fatally burned the two men that were still in the building.

Using water drafted from a cooling pond, Albany firemen confined the fire to half of the 50 ft. by 240 ft. 1-story masonry, wood-



Merrill Jones

OTHER METALS, REFINING AND SMELTING (Vanadium refining), near Albany, Oreg. A violent reaction inflicted fatal burns on two employees of the Oregon Metallurgical Corp. on Jan. 31. The ensuing fire destroyed half of the 240-ft.-long building, but the Albany Fire Department kept the fire from the communicating section where large quantities of combustible metals were stored. See report starting on page 352.

joisted building. The uninvolved half of the structure was used for storage of 50 cartons of titanium shavings, 70,000 pounds of titanium sponge in metal barrels and about 1,200 barrels of zirconium turnings. It is remarkable that the fire did not involve these combustible metals since the masonry wall that separated the storage area from the Research and Development Department had an unprotected doorway and extended only to the eave line.

March 16, Long Branch, Ont., Dominion Stores $435,000

SUPERMARKET. Employees believed that they put out a fire in a storage room at the rear of the store and did not call the fire department. After the store had closed for the day, a passer-by saw flames and gave the alarm at 6:13 P.M.

Although the fire department report lists the cause as rekindling, no evidence was presented that the fire had been completely extinguished by the employees.

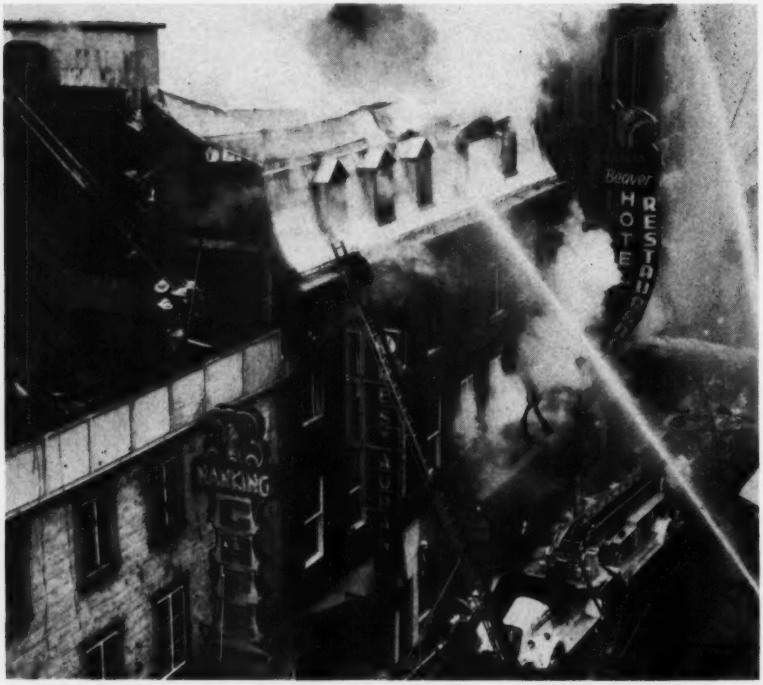
The fire was burning vigorously in the unsprinklered masonry wood-joisted building when fire fighters arrived. The roof collapsed before the blaze could be controlled.

Sept. 13, Cleveland, Ohio, Theatrical Grill, Inc. $250,000

NIGHT CLUB. A fire, originating in the basement of this unsprinklered 1- and 3-story brick, wood-joisted night club, burned for about half an hour before being discovered when one of the few employees present smelled smoke. She and a porter opened the first floor door of the dumb-waiter shaft and were met by smoke rising from the basement. The employee called the catering manager, who came downstairs, verified the fact that there was smoke and then asked the woman to call the fire department. The telephone service went dead immediately following the fire department notification.

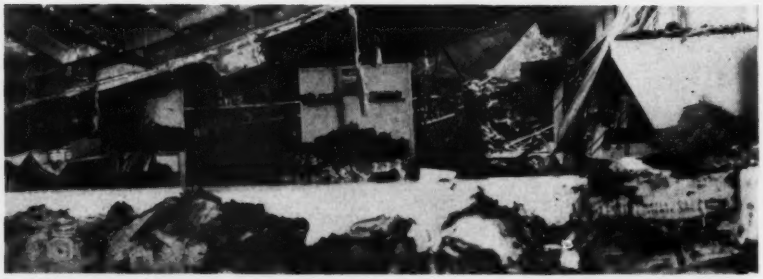
A female employee, trapped by smoke in the kitchen, was promptly rescued by fire fighters who broke down a locked rear door. They encountered great difficulty in fighting the fire as extensive remodeling of the former brewery had created numerous hidden passages which prevented water from reaching the seat of the blaze.

Fire spread rapidly from one floor to another through the concealed spaces, involving large amounts of combustible interior finish and contents of the club. In extinguishing the 5-alarm blaze, fire fighters from 22 companies used 39 2½-in. and 5 larger lines to deliver 4,186,430 gallons of water. A properly installed automatic sprinkler system could have extinguished the fire with the use of less than 1,000 gallons of water with correspondingly less damage.



W. B. Edwards

RESTAURANT, Quebec, P. Q. The Oct. 22 fire started in the kitchen of the first-story Beaver restaurant and was discovered by occupants of a rooming house in an upper floor of the 4-story building. It is believed that the 4:16 A.M. alarm to the fire department was delayed about an hour by the rooming house manager who, during this period, assured roomers that there was no immediate danger. Fire fighters were greatly hampered in attacking the $490,000 blaze by sewer construction excavations in the street at the front of the 85 ft. by 125 ft. property and the fact that the other three sides of the building had blank walls.



San Jose Mercury-News

SUPERMARKET, San Jose, Calif. This fire burned for some time before discovery by a newsboy at 5:41 A.M. Fire department response was further delayed when he gave the wrong address when telephoning the fire department. The 1-story, unsprinklered 80 ft. by 100 ft. Lucky Market was totally involved when firemen arrived. The March 20 fire caused $261,000 damage.

1960 Large Loss Building Fires —

Public Fire Protection

Fire departments in the U. S. and Canada vary from city to city as to their training, equipment and operational procedures as well as in manpower allotments, organizational policies and financial inducements. Each year thousands of fires are handled by adequately trained and properly equipped fire fighters. Unfortunately, also, each year there are large building fires, some of which are the direct result of faulty fire fighting practices. No criticism of any specific fire department is intended by this report. On the contrary, these stories are used to illustrate questionable practices with the hope that they will be entirely eliminated from present-day fire department procedure.

This section will also illustrate some of the hazards that face the fire service, so that a better understanding of the difficulties and limitations of manual fire extinguishment will result.

Sprinklers and the Fire Service

The role sprinkler systems play in connection with fire department handling of fires in buildings so equipped is of great importance since most sprinklered buildings involve either a high life safety hazard or a high property damage possibility. By failing to appre-

Paul Murray

EXHIBITION AND EXPOSITION HALL, Springfield, Mo. The hopeless odds which fire fighters often face upon arrival at burning property can be seen readily here. One of 5 suspects to the Sept. 7 fire admitted stuffing newspapers and rags into joist channels under wooden bleacher seats and igniting them in the 59,500 sq. ft. 1-story, stone, wood-joisted arena. When the first attempt did not "take" he returned and successfully ignited them, thus giving the $250,000 fire a strong start. The fire was discovered about 30 minutes later at 10:08 P.M. by a student in a school one-half mile away from the fair grounds. The photograph was snapped as the first truck laid in its lines.

Shifting winds spread fire to four unoccupied barns 30 to 60 ft. from the arena at the Ozark Empire Fairgrounds.

New York Fire Department

TEXTILE STORAGE, New York, N. Y. Three of the nine fire fighter deaths and 18 of 522 fireman injuries of the 1960 large loss fires occurred during the battle for control of the blaze in this 5-story masonry, wood-joisted building in downtown New York City on Nov. 18.

The $1,000,000 blaze was discovered and the alarm transmitted by a central-station-connected fire detection system. Flames spread rapidly from their basement origin to upper stories via open stair shafts and other unprotected vertical shafts.

Three of the 5 men first into the basement were unable to complete their escape. Trapped, they died in the unsprinklered structure. Previous fire department inspections had recommended complete sprinkler protection for the structure and standard enclosure of the vertical openings. It is fortunate that the fire occurred after working hours and that the building was empty at the time of the fire or the life loss might have been greater.

ciate the value and importance of maintaining effective water supplies to operating sprinklers, fire fighters can be responsible for permitting fires within sprinklered properties to spread beyond sprinkler control.

The most common mistakes in the past have been: (1) the practice of diverting the water needed for sprinkler operation to hose streams, instead of reinforcing the sprinkler system through the use of fire department connections to such systems and (2) the practice of closing the sprinkler valve too soon. (See Private Fire Protection for cases.) It is encouraging to note that neither mistake was a factor in the large loss fire experience of 1960.

Alarm Response

The adequacy of fire department response to the alarm of fire is an important consideration in the study of large loss fires. In the last few years failure to assign an adequate number of men to first alarm response apparatus coupled with failure to call extra help promptly when needed has resulted in the old problem of "too little — too late." This is just as dangerous as delayed initial discovery or delayed alarm.

The advent of radio-equipped apparatus has made it possible to provide a full, effective response on both first and subsequent alarms, but many communities fail to make full use of their facilities.

In 48 large loss building fires in 1960 time of the response of the fire department was a factor in the spread of fire. In 31 of these cases the running distance was exceptionally long. In 6 cases response was delayed by traffic congestion, in 3 cases by icy or slippery roads, in 2 cases by parked automobiles, and in one case each, response was delayed by simultaneous alarms, by a 2-ft. snowfall, by waiting for the man with the key to the fire station, by sending the police to investigate the alarm, by sending one pumper to a hospital fire alarm, and by refusing, due to legal problems, to work outside city limits.

Dec. 31, Port Arthur, Tex., Park Place Hospital, Inc. $250,000

HOSPITAL. While gasoline was being pilfered from this private hospital's emergency

Wide World

HOSPITAL, Port Arthur, Tex. The Park Place Hospital fire of Dec. 31.

gasoline generator, gasoline spilled, vaporized and ignited at a nearby natural gas-fired hot water heater.

The generator was located outside the building and under the eaves of the 1-story hospital itself. The under side of the hospital eaves was open allowing flames from the burning shed to enter directly into the unsprinklered attic space over the hospital.

Smoke was soon detected inside the hospital and the alarm was telephoned to fire department headquarters. One engine was sent to the hospital for the fire.

The temperature was in the 40's and a drizzling rain was falling. Patients who could walk were ushered to the lobby. Beds of nonambulatory patients were wheeled toward the lobby. The fire progressed above the ceiling rather rapidly. As smoke grew the patients were reluctantly moved to the outdoors and sent as quickly as possible to other hospitals.

Eventually 10 mutual aid companies joined the fight to save the building as the fire spread unhampered through the nonfire-stopped attic and undivided structure. About three-quarters of the roof was destroyed.

Aug. 28, Winslow, Ariz., Winslow High School $305,500

Gordon W. Terrill

PUBLIC SCHOOL. In the early hours of Sunday morning a school maintenance department employee saw flames in the town's high school from his home less than a half a mile from the building. He promptly telephoned the alarm. The fire phone rang in both the police and fire stations. The paid fire fighter on duty instructed the police to verify the alarm. A policeman went the eight blocks to the school and on arrival found flames coming through the roof of the unsprinklered building.

He called the police desk by radio and the police notified volunteer fire fighters before calling the paid fire fighter back and giving him the alarm. At this point the latter responded.

With time of the utmost importance in fire fighting there can be no excuse for this type of procedure.

Manpower

Fire Department manpower deficiencies were noted in 29 fires: 17 due to insufficient manpower; 11 due to inadequately trained fire fighters, and 1 because manpower was slow in assembling.

Equipment

The following equipment deficiencies were reported by the fire chiefs as being a factor in 36 fires. Twenty-six reported the lack of or insufficient aerial ladders, 23 complained of inadequate pumper capacity, 17 noted the need for special service equipment and 2 reported equipment breakdown at the fire scene.

March 2, Eugene, Oreg., Hoffman Hotel $250,000

HOTEL. The 31 guests on the three upper floors of this unsprinklered 4-story brick, wood-joisted building just managed to escape with the help of firemen after smoke cut off the open stairway and elevator shaft. The fire originated in a first-floor clothing store and was believed set by a drunken man who had been refused a room in the hotel at 3:00 A.M. Guests who noticed smoke told the hotel clerk, who in turn called the fire department at about 3:50 A.M. The fire department arrived promptly but fire fighting had to be delayed another 30 minutes as available firemen were needed to guide guests through smoke-filled halls to fire escapes or to ladders. During this time the fire spread up the stairway and mushroomed through the attic.

Water Supply

Inadequate water supply was a factor in 92 fires. In 65 cases the fire department reported the need for more water. In 16 cases there was no public water

Quincy Herald-Whig

PRINTING, TYPESETTING, Kahoka, Mo. After a coffee break the evening shifts returned to work at Moore Business Forms, Inc. An operator on a carbon coating machine switched on the blower system to the machine. Dust ignited from the switch spark and before portable extinguishers could be used the flames spread over paper dust and shredded paper through the unsprinklered structure. The sisal paper on the roof insulation ignited and dropped to the floor igniting paper on the floor.

The local fire department tried vainly to save the doomed building. They used all the public water (175,000 gallons) available and then hauled water in 4 tank trucks from a quarry pit. The unsprinklered building not only suffered a $1,000,000 property damage, but also suffered an identical insured business interruption loss from this Apr. 18 fire.

B. Sellers

PUBLIC SCHOOL, near Memphis, Tenn. Water was conspicuous by its absence at this fire on November 18. The fire was set in a locker room during afternoon classes at the Ford Road Elementary School. Fire fighters from Memphis and the Whitehaven Utility District were unable to control the fire since the only water available was the few hundred gallons which were carried in booster tanks on apparatus. Using water supplied by a 1,000-gallon tank truck that shuttled between the fire and a Memphis hydrant, firemen were able to save exposed school buildings. The county water mains ran in the road in front of the school, but no one had installed hydrants on them.

Thomas J. Lynch

CLOTH COATING, Clifton, N. J. Delaying the alarm to the fire department creates a grave hazard to fire fighters as demonstrated by the destructive fire at Velveray Corp. on Feb. 17. The complete report of the destruction of this 4-story, brick building is given on page 330.

supply; in 6 cases there was no "other-than-public" water supply and in 5 cases the "other-than-public" water supply was inaccessible for fire department use. In 9 of the 65 poor supply cases, the water demand to serve both manual fire fighting and sprinkler needs was inadequate.

Hydrants

At the scene of 37 of the 1960 large loss fires, fire chiefs reported there were not enough hydrants available. In 6 additional cases the hydrants were frozen or defective, and in 4 others the hydrants were not usable as they were too close to the involved building.

May 6, Mulgrave, N. S., St. Lawrence Church, et al. $250,000

CHURCH. A brush fire that for a time threatened the safety of the town destroyed a 104-year-old wooden church, the adjacent rectory, a garage and a dwelling. Driven by high winds, embers from the brush fire landed on the ornate wooden steeple from where fire spread inside and down into the church. Lack of water severely limited the small fire department and help that eventually arrived from towns 10 and 40 miles away. Salt water pumped from the ocean about 1,000 feet away and water brought to the scene by a bucket brigade of townspeople was used to save other threatened buildings and to check the brush fire.

July 3, Vancouver, B. C., British Columbia Forest Products, Ltd. $2,981,000

SAW AND PLANING MILL. Eighty-three per cent of this 14-acre sawmill consisting of 4 acres of wooden buildings and 4,500,000 board feet of cut lumber was destroyed by this fire. Most of the buildings and some of the yard storage area were built on a wooden deck supported by piles.

Fire due to a welding operation started in the undivided and unsprinklered concealed space under the wooden deck and burned up into the buildings through various floor openings. The sprinklers in the buildings above the deck began to open but could not

Newark News Photo

IDLE OR VACANT PROPERTY (Conflagration), Newark, N. J. High winds increase the difficulty of controlling fire once it has broken through windows, doors or fire-created openings. Sometimes the key extinguishing operations can only be set up on the leeward side of a fire because of topographical and structural obstructions and an effective attack is seriously delayed by these combined adverse factors.

Over 4¾ miles of hose and over a tenth of a mile of ladders were used to control this April 15 fire of suspicious cause which escaped from the coal yard of origin. Flames were whipped by 35 mph winds into a large wooden trestle beside the coal yard and thence to nearby wooden buildings. The wind-fanned fire crossed 3 streets and destroyed or damaged 23 buildings, including a school and mercantile property, but mostly combustible 3-story dwellings. The fires that broke out in the upper stories of dwellings created a difficult fire control situation. While a pre-Easter holiday crowd further hampered fire fighters and responding equipment, heavy hose streams and a good water supply permitted control of the conflagration in 3 hours.

reach the seat of the fire underneath. As more and more sprinklers opened, the water pressure dropped and the fire spread into the buildings. At least 1,350 sprinklers were estimated to be open and operating at the time of fire department arrival minutes after the discovery and prompt alarm.

Fire spread throughout the concealed space beneath the deck and through all buildings and piles of lumber on the deck. It also spread to buildings and lumber storage on adjoining filled land. A massive water attack through use of 30 2½-inch lines, 4 turret nozzles, and 2 fireboats (25,000 gpm combined capacity) brought the fire under control after about 3½ hours. In addition to the property damage there was an insured business interruption loss of $700,000.

Hazards of Fire Fighting

It should not be forgotten that in each of the fires reported in this story, fire fighters faced the normal hazards of manual fire fighting.

One or more of the following hazards to manual fire fighting was mentioned as a factor in the amount of loss in each of 210 fires: heavy smoke (91); high winds (41); explosion during fire (38); blank walls impeding access (36); congested buildings impeding access (23); extreme cold, ice, or snow (20); height of building impeding access (13); explosion preceding fire (11); locked doors impeding access (7); explosion at start of fire (6); spectators interfere (6); toxic gases and vapors (4); leaking gas mains (4); no basement entrance impeding access (4); yard storage impeding access (4); body of water impeding access (4); railroad tracks impeding access (3).

1960 Large Loss Building Fires—

Conclusion

The only requirement for a large loss fire is that it destroy $250,000 worth of property. This can happen in a closet full of expensive radar equipment, or it may come about only by the destruction of several buildings. Large loss fires can be prevented by limiting the value subject to a single fire or by providing protection to limit fire spread. If values of $250,000 are worth protecting, then the protection must be provided by someone. Thus the key to elimination of large loss fires is people.

Responsibility for Large Loss Fires

The *architect and engineer* have the responsibility to provide a safe structure. Undoubtedly the buildings are designed to stand for a long time. The calculations for foundation strength, earthquake protection and wind loading normally receive ample consideration, but all too often considerations of fire safety — value subdivisions, hazard cutoffs or private protection equipment — are overlooked with the result that a building, otherwise strong and safe, is destroyed by fire.

The *owner or occupant* has the responsibility to preserve his property. He must not only protect and maintain the heating, the plumbing and the exterior finish, but he must also maintain the fire protection equipment provided to limit fire spread. Those who would never yank out a column, open up a foundation, or cut into a pipe without careful thought as to the effect of their action will often, without any hesitation, puncture a fire wall, close a sprinkler valve, remove doors on stair wells, or allow their fire protection equipment to deteriorate.

The responsibility of the *watchmen and guards* should be emphasized. These men often are the only occupants of and are entirely responsible for, a valuable building. During working or operational periods, buildings may house workers with a payroll worth thousands of times the watchman's salary. During these periods management sees to it that the operations conducted in the building are under the supervision of qualified and highly paid persons, but at night an entire structure may be left in the hands of someone who has not had proper instructions, or proper training. It is during this period that many of the large loss fires occur.

Fire protection officials have even greater responsibilities. Fire chiefs, fire inspectors, fire protection engineers, fire equipment designers and salesmen, must work together to explain the importance of proper building design and to show the value and adaptability of private fire protection equipment.

Educators — those teaching engineering and architecture, have the responsibility to see that each graduate is properly armed with the basic principles of fire protection, and that each man recognizes the power he commands over life and death through correct or incorrect design. A simple omission of a relatively inexpensive fire door can result in a severe loss.

Insurance agents and brokers hold a similar responsibility to advise their clients on the importance of installing and maintaining a high level of fire safety in their properties, not only in the interests of preventing material losses but also of providing life safety.

It is only through the recognition and acceptance of these responsibilities that proper fire protection will be provided. Once this problem of responsibility is resolved, then the lessons of large loss fire experience shown in this issue of the QUARTERLY can be fully implemented.

Table I

Factors Responsible for 2,283 Large Loss Building Fires During Period 1953-1960

NOTE: The figures in this table indicate the number of times each factor was noted as influencing fire spread or the extent of damage in the 2,283 fires. In addition to the listed items many less frequently occurring factors were also reported. A combination of two or more factors was responsible for most of the large losses. The **boldface** type indicates the 1960 experience. The *italic* type indicates experience during period 1953–1959. The lightface roman type indicates the total 1953–1960 experience.

Principal Structural Defects Influencing Fire Spread

	Total		Industrial	Mercantile	Storage	Residential	Educational	Misc.
FIRES ANALYZED 1953-1959	*1964*	...	*672*	*413*	*342*	*99*	*107*	*331*
Fires Analyzed 1960	....	**319**	**126**	**71**	**48**	**20**	**17**	**37**
Horizontal Spread								
FIRE DIVISION WALLS								
Too few in attics.....	*235*	**61**	27	117	17	32	46	57
Too few in basements..	*75*	**6**	8	33	3	12	4	21
Too few in other stories.	*953*	**139**	462	181	230	33	47	139
Substandard constructions.....	*85*	**2**	17	27	9	6	3	25
FIRE WALL OPENINGS								
No protection for opening.....	*116*	**11**	60	21	23	2	6	15
Fire doors blocked open or inoperative.....	*30*	**4**	14	4	6	...	3	7
Substandard protection for openings.....	*19*	**3**	11	5	1	1	2	2
Vertical Spread								
Stairwells not enclosed...	*544*	**51**	146	171	88	62	41	87
Elevator shafts open.....	*225*	**8**	71	53	69	21	9	10
Nonfirestopped walls.....	*221*	**47**	13	101	9	30	29	86
Conveyor, machinery openings not protected.....	*82*	**15**	63	5	27	1	...	1
Stairwell enclosure substandard.....	*60*	**26**	14	41	7	10	3	11
Pipe openings not enclosed	*23*	**2**	7	6	2	2	1	7
Elevator shaft enclosure substandard.....	*29*	**3**	10	9	4	6	...	3
Other openings, no or substandard protection....	*62*	**8**	30	10	9	5	7	9
Combustible Interior Finish								
Fiberboard.....	*106*	**31**	23	58	10	7	9	30
Other interior finish.....	*64*	**9**	16	22	4	10	5	16
Oil-soaked floors.....	*41*	**8**	24	3	2	...	5	15

Table I — Continued

	Total		Industrial	Mercantile	Storage	Residential	Educational	Misc.
Building Equipment (1960 only)								
No dampers or shutters in ducts	...	**14**	...	8	...	...	4	2
Boiler or other building equipment not cut off	...	**8**	2	3	1	1	...	1
Air-conditioning equipment, fans, spread smoke, fire	...	**2**	...	1	...	...	...	1
Other building equipment factors	...	**4**	3	...	1	...	...	...
Spread to Exposures								
Congested combustible const., no exposure protection	*382*	**41**	170	51	72	22	3	105
Poorly constructed party walls	*99*	**15**	15	73	10	8	...	8
Interconnecting passageways, conveyors	*66*	**2**	31	11	15	7	...	4
Ordinary glass windows	*58*	**9**	10	26	9	8	2	12
Yard storage between bldg.	*33*	**4**	16	...	6	...	...	15
Other reasons for spread	*113*	**20**	49	32	18	7	3	24

Principal Contents Influencing Fire Spread

	Total		Industrial	Mercantile	Storage	Residential	Educational	Misc.
FIRES ANALYZED 1953-1959	*1964*	...	*672*	*413*	*342*	*99*	*107*	*331*
Fires Analyzed 1960	....	**319**	**126**	**71**	**48**	**20**	**17**	**37**
Flammable Liquids								
Escaped from tanks, drums	*246*	**27**	145	50	41	3	6	28
Escaped from auto, aircraft tanks	*55*	**3**	8	5	10	1	1	33
In process equip. (1958 to 1960 only)	*18*	**15**	27	4	1	...	...	1
Container explosion	*43*	**13**	26	8	14	...	...	8
Escaped from pipes	*29*	**7**	27	2	1	...	...	6
Other flammable liquid factors	*98*	**14**	57	15	15	1	2	22
Storage Methods								
Poor stock subdivision	*246*	**23**	68	62	120	3	...	16
Stock piled too high	*108*	**22**	30	24	55	...	1	20
Inadequate window clearance	*31*	**5**	6	11	18	...	...	1
Other storage factors	*166*	**11**	31	35	75	3	3	30
Housekeeping								
Dust on structural members, etc.	*152*	**29**	135	7	27	...	4	8
Rubbish accumulations	*71*	**5**	25	19	15	4	1	12
Other housekeeping factors	*68*	**30**	68	10	8	3	1	8
Gases								
Natural gas	*43*	**9**	22	10	6	4	1	9
Acetylene	*18*	**6**	16	1	1	...	1	5
LP-Gas	*17*	**6**	7	9	9	2	...	2
Other gases	*38*	**5**	26	3	7	1	...	6

Table I — Continued

Principal Private Fire Protection Defects Influencing Fire Spread

	Total		Industrial	Mercantile	Storage	Residential	Educational	Misc.
FIRES ANALYZED 1953-1959	*1964*	...	*672*	*413*	*342*	*99*	*107*	*331*
Fires Analyzed 1960	....	**319**	**126**	**71**	**48**	**20**	**17**	**37**
Sprinkler Protection								
No sprinkler system	*1656*	**259**	555	464	335	86	119	356
Complete protection — unsatisfactory performance	*125*	**21**	103	1	26	5	1	10
Hazard too severe for system installed	*25*	**3**	25	...	2	...	...	1
Water supply poor or failed	*22*	**3**	17	...	5	2	1	...
Valves closed for miscellaneous reasons	*26*	**5**	16	...	6	2	...	7
Explosion damaged system	*18*	**5**	21	1	...	...	...	1
Valve closed too soon	*12*	**3**	12	...	3	...	...	...
Other reasons	*22*	**2**	12	...	10	1	...	1
Partial protection — unsatisfactory performance	*38*	**9**	28	4	6	5	1	3
Origin in unsprinklered areas, spread to sprinklered areas	*32*	**4**	22	4	4	3	1	2
Valve closed, defective	*3*	**2**	2	...	1	1	...	1
Other reasons	*3*	**3**	4	...	1	1	...	...
Fire Detection								
No watchman or automatic detection	*1125*	**159**	300	349	214	79	97	245
Unsatisfactory watchman service	*273*	**30**	130	30	59	12	17	55
Failed to detect fire promptly	*169*	**22**	79	19	37	7	10	39
Patrolled outside building only	*19*	**4**	7	4	6	2	...	4
Protected area too large	*16*	...	6	1	1	...	5	3
Asleep	*9*	**1**	4	1	4	...	...	1
Other reasons for watchman failures	*60*	**3**	34	5	11	3	2	8
Unsatisfactory automatic detection	*12*	**8**	9	1	3	2	...	5
Fire Alarm Transmission								
Transmission delayed	*398*	**80**	172	90	68	40	21	87
Occupants fought fire	*148*	**31**	69	34	34	11	5	26
Telephone wires burned	*43*	**4**	14	10	2	8	2	11
Telephone inaccessible	*23*	**10**	16	5	4	2	2	4
Watchman fought fire	*12*	**3**	6	...	4	...	...	5
Other reasons for delayed transmission	*172*	**32**	67	41	24	19	12	41
Fire Brigades								
No fire brigade	*264*	**47**	158	23	59	20	9	42
Unsat. performance	*72*	**7**	38	1	14	1	3	22
Fire too advanced on discovery	*21*	**2**	12	1	8	...	...	2
Insufficient equipment	*10*	**3**	7	...	2	...	1	3
Other reasons	*41*	**2**	19	...	4	1	2	17

Table I — Concluded

	Total		Industrial	Mercantile	Storage	Residential	Educational	Misc.
Portable Fire Extinguishers								
No fire extinguishers	*10*	**2**	3	1	4	1	...	3
Unsat. performance	*280*	**52**	140	43	55	21	14	59
Fire too advanced on discovery	*168*	**11**	80	17	25	13	8	36
Wrong type for class of fire	*46*	**13**	20	9	15	2	1	12
Other reasons	*66*	**28**	40	17	15	6	5	11
Standpipes and Hose Systems								
No system	*183*	**49**	95	33	45	12	7	40
Unsat. performance	*126*	**18**	83	2	15	9	12	23
Fire too advanced on discovery	*71*	**5**	45	1	9	2	6	13
Other reasons	*55*	**13**	38	1	6	7	6	10
Special Extinguishing Systems								
No system	*68*	**8**	43	5	5	1	...	22
Unsat. performance	*9*	**2**	10	1	...	...	...	...

Table I — Concluded

Record Protection Equipment (1960 only)								
No data available	....	**130**	50	32	22	8	7	11
No record protection	....	**24**	9	4	3	1	...	7
Unsat. performance	....	**8**	2	3	1	...	2	...
Inadequate rating for exposure	....	**3**	1	2	...	...	...	...
Unlisted devices	....	**2**	1	...	...	...	1	...
Other reasons	....	**3**	...	1	1	...	1	...

Principal Public Fire Department Handicaps Influencing Fire Spread

	Total		Industrial	Mercantile	Storage	Residential	Educational	Misc.
FIRES ANALYZED 1953-1959	*1964*	...	*672*	*413*	*342*	*99*	*107*	*331*
Fires Analyzed 1960	....	**319**	**126**	**71**	**48**	**20**	**17**	**37**
Water Supplies								
Inadequate	*235*	**56**	124	40	55	18	30	24
No public supply	*94*	**16**	52	11	22	9	8	8
Inadequate water for hose streams and sprinklers	*62*	**9**	47	...	11	4	...	9
Insufficient hydrants	*89*	**37**	49	19	24	5	9	20
Equipment and Manpower								
Insufficient equipment	*298*	**66**	89	77	43	36	29	90
Insufficient manpower	*130*	**17**	39	46	16	11	6	29
Manpower not properly trained	*67*	**11**	27	19	13	6	4	9
Fire Fighting								
Heavy smoke	*241*	**91**	78	121	53	16	9	55
High winds	*165*	**41**	72	33	27	12	11	51
Explosions preceding fire	*99*	**11**	71	13	12	3	1	10
Explosions during fire	*137*	**38**	64	44	30	3	2	32
Access impeded by blank walls	*105*	**36**	28	62	25	...	...	26
Flowing flammable liquids	*42*	**4**	27	2	8	1	...	8

Large Loss Fires Not in Buildings

There were 72 large loss fires involving property outside of buildings. These 72 fires caused 142 deaths, 434 injuries and $187,581,500 property damage.

Other than the 33 aircraft fires reported on pages 375–390, there were 39 fires causing 64 deaths and $98,714,000 property damage. These 39 fires include 24 forest fires, six transportation fires (other than aircraft) and 9 miscellaneous other fires not involving buildings.

The 9 large loss fires in property outside of buildings, other than forest and transportation fires, caused 8 deaths, 30 injuries and $6,521,500 property damage. These fires are indicated in Table II by a dagger in front of the date.

Wide World

OUTDOOR PUBLIC ASSEMBLY, Memphis, Tenn. A cigarette that was dropped through a crack in the wooden stands during an afternoon ball game on April 17 is believed to have started a fire in trash under the stands. The fire spread through the undivided space beneath the grandstand and burned up into the seats before being discovered by an employee at adjoining property at 7:28 P.M. Fanned by 23-28 mph winds, the fire spread rapidly through the seats and also destroyed the wooden grandstand roof. Fifteen nearby retail stores were destroyed. Dense smoke required evacuation of some patients from two hospitals across from the burning ball park.

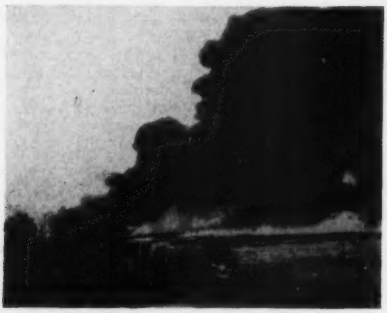
The ball park watchman did not discover the fire as his hourly tour consisted only of a visit to the center of the stands where he looked in both directions before returning to his rest area.

All 8 deaths occurred in two of the three petroleum refinery fires. The 6 other incidents occurred in: outdoor storage (2); outdoor public assembly (1); a gas manufacturing plant (1); an electric generating plant (1); and a wharf (1).

Aug. 18, Toronto, Ont., Levy Auto Parts, Ltd. $300,000

OUTDOOR STORAGE. An employee discovered fire in wooden cases containing new and used automobile parts in an open customs compound at 4:12 P.M. The parts were packed in grease and wrapped in waxed paper and these flammables accelerated fire spread. It is not known what started the fire. Seven 2½-inch lines were required to check the spread and extinguish the fire.

June 9, Seaford, Del., E. I. du Pont Co., $500,000

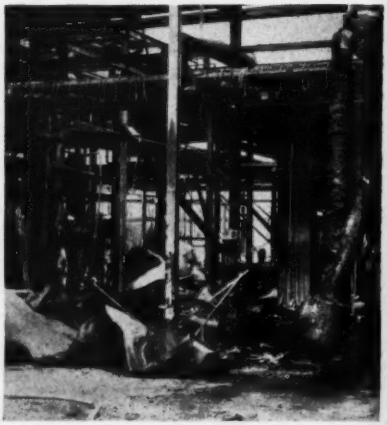


The Seaford Leader

OUTDOOR STORAGE. A small fire on June 8 in baled waste nylon, stored outdoors in 7-ft.-high rows covered with polyethylene sheets, is believed to have been started by hot carbon from a nearby asphalt plant smokestack. Although the plant brigade and fire department controlled the incident, all of the storage in the 5-acre yard was involved the next day. This second fire may have followed redevelopment of the original fire, or may have been caused by a second ignition by hot carbon. Discovery of the second fire was delayed. Fire fighters were able to keep flames from involving large asphalt storage tanks only 30 ft. away.

Oct. 24, Freeport, Texas, Dow Chemical Co., 6 killed $325,000

PETROLEUM REFINERIES. While a relief valve was being removed from an evaporator



Wide World

for maintenance, the vessel ruptured without warning. A boiling mixture of allyl choride and propylene chloride was released and the hot vapor exploded. Flying pieces of metal and flames from the burning vapor injured 15 workers and killed 4 others. Two of the injured subsequently died.

Subsequent investigation revealed that the failure occurred from uniform corrosion which had thinned the walls of the vessel over such large areas that it was not detected during periodic visual inspections. Water remaining in the vessel after frequent cleanings may have formed an acid which attacked the copper-silicon alloy vessel walls. While the vessel had satisfactorily passed a 60 psi hydrostatic test a few months earlier, it failed at 38 psi. The men working on the tank at the time of the rupture may have subjected the tank to an additional stress or shock which in its weakened condition caused failure.

Forest Fires

There were 24 forest fires in 1960 each of which caused a loss of over $250,000. Twenty-one were in the United States — California (14), Idaho (2), South Dakota (2) and one each in Montana, Oregon and Washington; while three were in Canada — Quebec (2), British Columbia (1).

These fires caused an estimated total loss of $40,750,500, took 5 lives and in-

(Continued on page 373)

Wide World

A helicopter pilot was one of the 5 persons killed by forest fires.

Wide World

Blackened wastes covering 319,000 acres remained after the 24 large loss forest fires. Individual large loss forest fires ranged in size from 465 acres to 48,777 acres as shown in Table II, page 405.

Arkansas State Police

RAILROAD ROLLING STOCK, Traskwood, Ark. On Dec. 17, a hotbox on an oil tank car 65 cars back from the engine, derailed that car and the 22 cars immediately following it. A fire immediately developed in the pile-up; and after 40 minutes an explosion occurred, making a crater 100 feet in diameter and 30 feet in depth. A man hunting in the woods nearby was injured but otherwise there were no casualties, due primarily to the fact that the wreck occurred in a remote location. There had been no fire fighting.

One of the 23 derailed cars contained 1,250 bags of fertilizer-grade ammonium nitrate. Following the explosion, no identifiable parts of this car could be found. Other contents of the derailed cars included fuel oil, gasoline, lubricating oil, fuming nitric acid, nitrogen fertilizer solution and bulk fertilizer-grade ammonium nitrate.

Ottawa Herald

RAILROAD ROLLING STOCK, Ottawa, Kans. On Aug. 28, two freight trains speeding past each other on parallel tracks collided when a truck on one car broke. As the cars of both trains piled up on a bridge, fires broke out. The bridge collapsed, dropping many cars into the creek bed.

Police had difficulty holding spectators back until after the first LP-Gas tank car ruptured violently. After this the spectators willingly kept back a safe distance, so that the second and worst rupture did not injure anyone. Debris was blown several hundred feet by the second tank car rupture. A piece of the tank tore off half of a farmhouse 500 feet away and knocked down two trees before coming to rest in a road. Only two of the 15 LP-Gas tank cars involved ruptured; four of the others burned peacefully for over eight days.

jured 23 persons. Cost of suppression is not included in this figure. In the 22 fires for which the suppression cost was available, it totalled $10,186,000.

The bare statistics of Table II do not present the vicious nature of a forest fire. The report below gives an idea of the impact of one of these 24 serious 1960 blazes.

Oct. 15, Napa, Calif., The Soda Canyon Fire, $802,000

FOREST FIRE. A resident of Soda Canyon was burning trash in his door yard when a high gusty wind developed (40 to 50 mph). Burning embers ignited the brush. The humidity at the time was 8 per cent. The flames spread rapidly through the heavy brush.

The very steep slopes and lack of roads in the area, the low humidity, and the high wind combined to present a difficult fire fighting situation.

"Waterfalls" of sparks showered the roofs of buildings near the fire area. Ten dwellings and 32 other structures were destroyed, along with pets and 4,000 acres of brush.

Transportation Fires

There were 39 large loss transportation fire accidents. These accidents took 129 lives, injured 381 persons (aircraft injuries not included), and caused $140,309,500 property damage.

The 33 aircraft fires are summarized in the following article on "Large Loss Aircraft Fires."

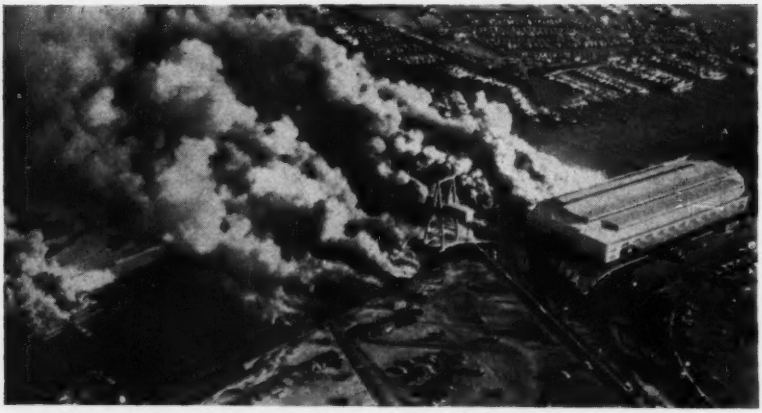
The 6 other transportation accidents killed 51 individuals, caused 381 injuries and $51,442,000 property damage.

June 14, Pearl Harbor, Hawaii, U.S.S. Sargo, 1 killed, $1,000,000

WARSHIP (Nuclear submarine). During the transfer of liquid oxygen to the submarine from shore, a fire broke out in the aft torpedo room. Due to the difficulty of reaching the area of the fire, it was decided to put out the fire by flooding. Water-tight doors were closed to seal off the torpedo room from the rest of the submarine, the torpedo room deck hatch was left open, and the after tanks were flooded. As the stern submerged, water flowed into the torpedo room through the hatch opening.

Wide World

The U.S.S. Sargo afire in Pearl Harbor, June 14.



Wide World

The pier fire at Los Angeles, Calif., March 17, 1960.

A barge was obtained to raise the stern and the water was pumped out. The fire was still going. Foam lines from shore and from tugs finally completed extinguishment.

A sailor, who was in the torpedo room when the fire broke out, lost his life.

Dec. 19, Brooklyn, N. Y., U.S.S. Constellation 50 killed, $47,942,000

WARSHIPS (Aircraft carrier). A flammable liquid fire on the hangar deck of this aircraft carrier under construction trapped and killed 50 men, injuring 376 others. A complete report may be found on pages 283–291 of this issue of the QUARTERLY.

March 17, Los Angeles, Calif., Los Angeles Harbor Department $1,000,000

PIERS AND WHARVES. Sparks from a welder's torch are believed to have ignited a new pier being built. The welder had been working on a large crane being installed over the pier, constructed of double thickness 2-in. by 12-in. planks on 4-in. by 4-in. framing on creosoted pilings. Flames spread in both directions and endangered a new terminal building. The wind drove the heavy creosote-filled smoke waterward and prevented effective use of fireboats except at the ends of the burning section. Fire was contained after 7 hours of fire fighting but was not extinguished for another 24 hours.

Aug. 19, Lake St. Peter, P. Q., Belle Isle II $750,000

SHIPS (Coaster). While the Belle Isle II was proceeding through a wide spot in the St. Lawrence River called Lake St. Peter, P.Q., she collided with another vessel. Equipment upset in the galley, starting a fire which burned out all combustible material and forced all on board to abandon ship. She then sank as her engine room and pumps had been flooded due to the collision.

Large Loss Aircraft Fires of 1960

There are 33 large loss aircraft and missile fires in the 1960 records of the NFPA occurring in the United States and Puerto Rico. There were no large loss aircraft fires in Canada last year.

In these accidents, 79 deaths are attributed to fire or a combination of impact injuries and fire, 63 of the victims being occupants of the aircraft involved. The other 16 were trapped by the resulting ground fires. In the December 16 accident in Brooklyn and Staten Island, New York, 128 occupants of the two aircraft involved in the mid-air collision died but these deaths are not included in the total since the loss of life must be charged basically to the aerial contact which disabled both aircraft.

The dollar loss from the 33 fires is figured at $88,867,500, not counting in full some of the aircraft losses which are not chargeable directly to fire. In many cases it was impossible to divide the loss between impact and fire damages. In such cases the total loss figure was used. Wherever impact damage could be separated from the total loss, it has been done; in this year's tabulation $23,150,000 has been so segregated.

There were undoubtedly a number of other large loss aircraft fire incidents occurring in North America which are not reported. This is influenced by the difficulty in collecting all the experience, particularly losses sustained by the military services. It will be noted in the listing of these fires on page 403 that 85 per cent of the fires did involve military aircraft or missiles. Reports on these incidents are likewise not always as complete as we would like them since security restrictions apply in a number of cases.

Nineteen of the losses were due to crash fires, seven due to in-flight fires, and seven because of ground fires.

Crash Fire Incidents

The 19 large loss aircraft crash fires were cases where the force of the impact was not alone sufficient to demolish the aircraft and kill occupants unless they were accompanied by explosions or fires. In other words, fire contributed in a major degree to the extent of the damage and the loss of life (where there was any). Summarized herein are 11 of the crash fire incidents as typical of the experience, including 8 military aircraft accidents and 3 commercial transport accidents. The January 1961 NFPA QUARTERLY contained reports on a number of other crash fires in 1960 involving large loss of life including the B-52G accident of February 1 at Ramey Air Force Base, Puerto Rico, the KB50-J crash near Langley Air Force Base, Virginia, and the United Air Lines DC-8 and Trans-World Airlines Constellation mid-air collision and crashes occurring on December 16.*

Jan. 14, Eielson Air Force Base, Alaska, U. S. Air Force. B–47 $1,883,000; 2 killed

When this B–47 bomber crashed on a low approach to the Eielson Air Force Base, it presented difficult fire control problems because of:

*See January 1961 QUARTERLY, pages 251–257.

(1) An immediate, vicious crash fire;

(2) The fact that the aircraft crashed into a "Pacific" hut containing explosives in the ammunition storage area of the base with resulting detonations;

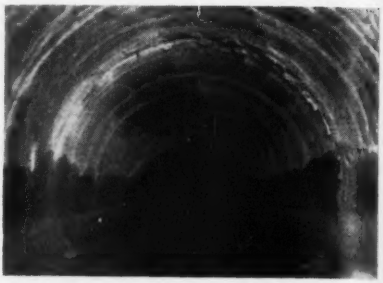
(3) A 3-foot-deep snow cover which prevented easy fire fighter movement and handicapped placement of equipment; and

(4) A severe ice fog which prevented observation of the crash and slowed response of the crash equipment.

The crash occurred at about 12:33 P.M.; the first alarm was sounded at 12:45 P.M.; the apparatus arrived at 12:50 P.M. The B–47 was completely involved when fire fighters responded with three major crash units, a rescue vehicle, a 1,000-gallon tanker, and a pumper. The "first-in" crash truck (an O–11A) was positioned near the fuselage with the intent of controlling the fire and attempting rescues. Severe detonations of high explosives (including 20 mm ammunition and normal pyrotechnics) accompanied by fragmentation required evacuation to preclude certain loss of life and equipment. No further effort to secure fire control could thus be attempted until this danger subsided. Fire fighters, wearing snowshoes to overcome the effects of the deep snow, did locate two survivors who escaped unaided and took shelter behind an uninvolved ammunition hut. Three Army M–59 armored personnel carriers, working as close in as the exploding high explosives permitted, searched for the remaining crew members, but the two victims could not be located until it was too late. There were no extensive fire fighting operations because of the described conditions.

Feb. 3, Walker Air Force Base, N. Mex., U. S. Air Force, three KC–135 aircraft and hangar $21,400,000; 9 killed

A report on this tragic accident was published in the January 1961 QUARTERLY, pages 251 to 253. As reported therein, loss of control during take-off resulted in one KC–135 crashing into two parked KC–135's on the ramp and then crashing into a hangar building. A tremendous fire resulted causing the second largest dollar loss of the year. The fire destroyed all three of the aircraft involved, one hangar, and 14 parked cars. Five crew members aboard the fuel-laden tanker plane died in the crash, and four occupants of the hangar were also killed.



Interior of 24-inch concrete storm sewer upstream from the headwall showing light spalling at water line.

Since the report in the January QUARTERLY was prepared, additional information has become available on the role played by the storm sewer in connection with the spillage of the jet fuel. This is of special interest because of recent work on aircraft fueling ramp drainage done by the NFPA Sectional Committee on Aircraft Hangars and Airport Facilities (see NFPA No. 415–T). There have been a number of fires in drainage systems where the drainage pipe itself contributed to the extent and severity of the fire. In the latter cases, the piping was asphalt-coated metal pipe, while in this case, the storm sewer was concrete.

At the Walker Air Force Base, the storm sewer for the ramp area involved consisted of 18-inch- to 30-inch-diameter reinforced concrete pipe in the main stem with 12-inch- and 18-inch-diameter reinforced concrete pipe in the laterals. Inlets were a grated type about 15 inches in width, 10 feet in length (with a center section 6 feet long and the remainder in two wings pointed upstream), and 5½ feet deep (measured from the pavement surface to the flow line of the pipe). The apron pavement in the area was 8½-, 9½-, and 10½-inch-thick concrete. Grades used in the drainage system are minimum in magnitude.

It is estimated that about 20,000 gallons of JP–4 fuel was spilled and burned on the apron at the inlets and in the outlet channel. The fuel was washed into the storm drain and was flushed to reduce the possibility of an explosion. The flushed material burned for approximately 1½ hours.

Most of the fire existed at the inlets and in the open ditch section of the drainage system downstream from the drainage pipe. Some flame was reported by witnesses above ground along the line of the storm sewer

at the pavement joints. This indicates that the spilled fuel vapor came up through the pipe joints and ground. Within the pipe, some fire did occur as noted by smoke discoloration in the noncombustible pipe, but this fire persisted only at the inlets because of oxygen starvation in the pipe itself. The 24-inch-diameter lines at the outfall headwall appeared more discolored than others, and it is clear that combustion continued for a longer period of time at this outfall than at the inlets. The storm sewer itself showed little actual damage directly attributable to the fire, and the system can continue to function as originally intended and installed.

Mar. 8, Carswell Air Force Base, Tex., U. S. Air Force, KC–135 over $3,000,000

After a KC–135 struck a building and landed short of the runway while landing in a heavy fog, the tanker plane overran the runway and burned. All seven members of the air crew escaped unaided before fire department personnel and equipment, delayed by the heavy fog, could reach the scene.

Wide World

All seven occupants escaped before fire destroyed this KC-135 which overran the runway.

The aircraft was totally involved in fire on arrival of the equipment and had broken into four main sections. The fire was attacked by the 58 responding firemen with foam and carbon dioxide from the three O–11A's and one O–6 crash truck, backed up by a water tank truck and three pumpers. The pumpers were used to relay water through 2½-inch hose lines from a runway hydrant some 1,850 feet from the crash site. The excessive hose line layout was seen to delay operations and present plans call for extending the present hydrants, installed each 1,000 feet along the active runway, to the overrun area. The loss of the aircraft was total. Five of the crew of seven received burns in making their escape.

Mar. 31, Little Rock, Ark., U. S. Air Force B–47 $250,000 ($3,150,000); 5 killed

"A plane explosion involving serious loss of life and property can occur in any city or town." This statement, appearing in the Foreword to the "Loss Report, Little Rock Fire Department, B–47 Bomber Explosion" is a realistic appraisal of the hazards presented by the modern air defense and air transport needs of the country and the world. During 1960 two other especially notable cases of the hazard of falling aircraft in built-up portions of cities occurred — on December 16 in Brooklyn, New York (see January 1961 QUARTERLY, page 255), and in Munich, Germany, December 17.

The Little Rock disaster occurred at 6:06 A.M., "on a day like any other day" under clear skies, temperature 42°F, humidity 89 per cent, wind ESE at 5 miles per hour. Two loud explosions were heard. Houses shook and windows cracked all over town. Eye witnesses saw flaming debris and one man in an open parachute falling from the sky.

Reported in the press as an air-borne "explosion" and as "a flaming six-engine jet bomber explosion," the probability is that the B–47 did not "explode" in flight from a flammable vapor-air mixture or a similar cause nor was it on fire in flight prior to the air-borne disintegration. Most likely, the big jet broke apart in the air after an air-borne maneuver too severe for its structural integrity. Clearly, fire occurred at the disintegration and showered flaming debris over a wide area of Little Rock with some parts narrowly missing four large hospitals. As it was, three separate areas of the city were seriously involved in the ground fires which resulted.

Wide World

A row of houses ignited in Little Rock after the B-47 disaster there.

One area was a residential area centering at Maryland and Summit Streets. Parts of the B-47 fell in the front yard of 816 Summit Street, exploded, and threw flaming fuel on the residence at 824 Summit Street, an apartment house at 1921–25 Maryland Street, and on a second residence at 1920 Maryland Street. These buildings were completely destroyed by fire and one occupant of the last mentioned dwelling died in the fire. Flaming parts of the aircraft fell on the roof of a Sunday school building, causing severe fire damage to that building. Flaming debris also fell on residences at 1814 and 1816 West 10th Street causing both impact and fire damages to these structures. The flaming crater of debris in front of 824 Summit Street caused some destructive heat radiation to other residences in the area, and heavy damage from falling debris was registered over a three-block area in each direction from the point of impact at 824 Summit Street.

A second area, also residential, centered at 211 Colonial Court (about 17 blocks west and 8 blocks north of Area 1). A part of the fuselage fell into the residence at 211 Colonial Court killing the occupant, destroying the home by fire, and wrecking a car parked there. One airman was found dead inside the wreckage of the plane that fell on the house, and a second was found dead on the front sidewalk. Considerable exposure fire damage occurred to homes at 205 and 213 Colonial Court. The third crewman to be killed fell on the school grounds of the Pulaski Heights Elementary School, also in this area. Falling plane parts fell throughout this neighborhood.

The third area of heaviest destruction was about midway between the other two at Eighth Street and Appian Way. A wing section (the largest segment of the aircraft to fall in one piece) fell across an electric transmission line, cutting off current to a major part of the northwest section of the city and cutting off power to police and fire department transmitters. An emergency generator restored the latter service with only a few seconds delay. The damage in this area was mostly impact damage from falling parts; with only small fires reported.

The men at Fire Station 7, only about 3 blocks from the Colonial Court disaster area, heard the air-borne "explosion" and saw the falling debris. They tried to call Headquarters but found the central station radio out of order. The district chief's car radio was serviceable to other apparatus but could not reach the central station. They responded with two pumpers to the vicinity of boiling black smoke and quickly found the burning homes on Colonial Court. By the chief's radio, help was called. By this time, the central station radio was back in service (after the emergency generator restored power) and coordination was re-established. Fire fighting commenced, with use of 2½-inch and 1½-inch fog nozzles on the burning dwellings. Some difficulty was experienced with nozzles becoming plugged with rocks in this early fire fighting which utilized a "dead-end" hydrant off a high pressure main.

At fire headquarters, the alarm operator had also heard the explosion, seen the falling plane parts, and then began receiving box and telephone alarms. Calls came from each of the three major damage areas before the telephone lines became "jammed" from calls for information as well as for help. The fire alarm tape shows that three boxes were pulled, one at 6:08 A.M. and two at 6:09 A.M. Fire alarm headquarters dispatched 4 pumper companies and 2 truck companies to the Maryland and Summit site. Asst. Chief Bell on arrival radioed a second alarm from his car radio. Help was called in from North Little Rock which answered with two pumpers and 11 men initially, later augmented by 13 more men. The Little Rock Air Force Base sent two crash trucks in answer to the alarm.

While early fire department activity was hampered by crowds, police quickly became active in evacuating and blocking public access to the restricted areas, and Auxiliary Civil Defense Police were utilized. Utilities attended to the power line break and the capping of severed gas and water mains.

There were a number of favorable factors: (1) the high humidity conditions, which prevented ignition of many combustibles by hot objects that rained from the sky; (2) the time of the accident, which was favorable, since many citizens were up and preparing for work; (3) automobile traffic, which was extremely light; (4) the fire and police departments, which were near shift changing time enabling fast mobilization of all available manpower.

The loss to the aircraft is about $2,500,000. The total property damage, including death and injury claims, is estimated at $650,000. The property insurance losses are estimated at $222,000. It appears fair to assign a fire loss figure of about $250,000 to the over-all loss figure of $3,150,000 for the aircraft, impact damages, and other claims.

Apr. 15, Lincoln Air Force Base, Nebr., U. S. Air Force, KC–97G $1,205,000

When the nose gear collapsed on a KC–97G during a normal landing on the runway at the Lincoln Air Force Base, propeller fragments punctured the wing tip tanks resulting in a serious fire which took 40,000 gallons of water, 3,200 gallons of foam liquid concentrate, and 8,000 pounds of carbon dioxide to control.

The fire was fought by the Air Force fire fighters (total number responding — 48) using four major crash trucks and support equipment including pumpers for hose relays and water tanker trucks. The five crew members and nineteen passengers aboard the tanker plane escaped unaided so that complete attention could be given to the fire control operation.

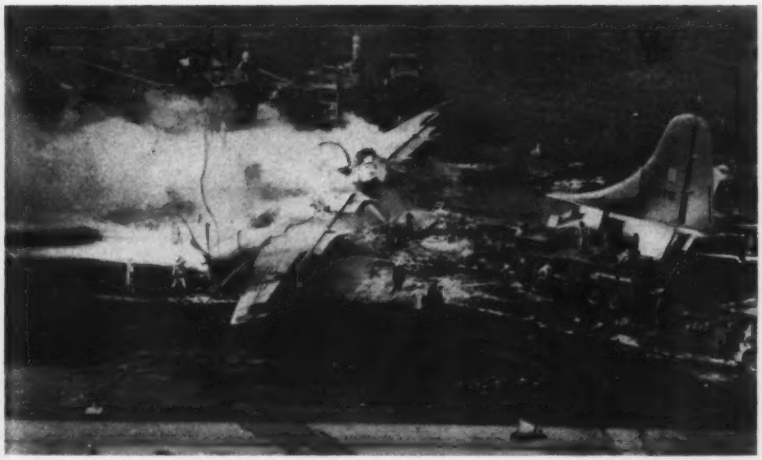
The alarm was instantaneous with the collapse of the nose gear, and the first apparatus was on the scene within two minutes. The aircraft had skidded off the paved runway surface into the dirt area immediately adjacent thereto. Some 62,000 pounds of JP–4 fuel and aviation gasoline were aboard the tanker plane when it crashed, and the entire fuselage section within 20 feet of the tail was ultimately consumed by the fire. In addition, both wings were damaged by the fire as well as three of the four engines.

The fire was controlled and ultimately extinguished with carbon dioxide and foam using the combined agent technique recommended in NFPA No. 403. The fire area was blanketed with foam and areas of burning magnesium were continuously blanketed until the magnesium burned itself out. Fuel cells in both wings still contained fuel after the extinguishment was completed, but, during the fire, venting of the vapors from the fuel cells made it particularly important to maintain a blanket over the burning magnesium.

The primary problem for the fire fighters was maintaining an adequate water supply. Some 2,300 feet of 2½-inch hose was laid from one hydrant with water delivered by relaying it through two pumpers. Another 800 feet of 2½-inch hose line was laid from a closer hydrant with pressure maintained by a 750 gpm pumper. The 2½-inch lines were wyed into 1½-inch lines on the fire grounds, these lines having foam nozzles with foam pickup tubes.

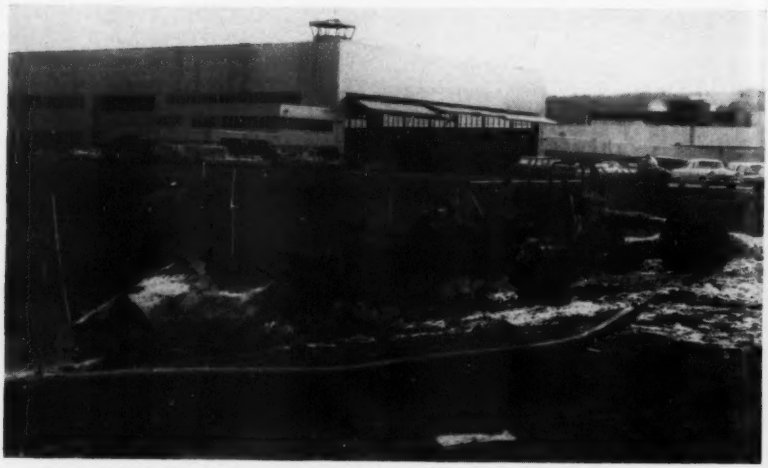
Apr. 23, Sikorsky Heliport, Stratford, Conn., U. S. Navy HSS–2 (S–61) $750,000; 3 killed

This tragic accident occurred during a test flight of this new turbine-powered helicopter at the Sikorsky Heliport resulting in the death of the test pilot, the copilot, and one Sikorsky engineer.



Wide World

After propeller fragments punctured wing tip tanks, the resultant fire destroyed this KC-97G at Lincoln Air Force Base on April 15. The tanker had 62,000 lbs. of JP-4 fuel aboard at the time of the accident.



While the accident site was only 400 feet from the fire station (see background), and it took less than a minute to reach the scene, fire destroyed this S-61 helicopter and its three occupants were killed.

The fire department had been alerted to stand by for the S–61 flight, and, thus, when the accident occurred, response was immediate. The accident site was only about 400 feet from fire headquarters so that it took less than a minute for the first truck to arrive. On arrival, however, a major fire had covered the entire helicopter. It was evident that the ground impact had ruptured the fuel cells and seriously deranged the structure making it difficult to locate the trapped victims. Foam was used in the initial fire fighting attack from one 500-gallon-water-capacity and one 1,000-gallon-water-capacity crash unit, with both using turret streams and hand lines to blanket the flames as quickly as possible. Within 3 to 4 minutes after the start of operations, the copilot was reached and his body removed. The pilot was found under the wreckage. The third occupant was pinned in by his seat belt and by control cables which had to be cut away before he could be moved.

While many accidents involving conventional aircraft involve thousands of gallons of fuel which handicap fire control, it is estimated that the fire in this case involved only about 375 gallons of JP–4. The intensity of fires during the critical period of possible rescue can be, as illustrated here, just as severe with this as with greater quantities. In this case, it is presumed that the three victims died of impact injuries due to the severity of the ground contact, but all three bodies suffered severe burns before they could be recovered.

May 9, New York International Airport, N. Y., Trans World Airlines, 707–331 $500,000

This accident illustrates dramatically the value of airport-based rescue and fire fighting services and also the magnitude of the problem of evacuation of aircraft of the size of the 707.

At 4:48 P.M. a TWA Boeing 707, Type 331, inbound from Los Angeles with 109 persons aboard crash landed on Runway 22L at New York International Airport. Apparently, the pilot was attempting to rise for a second instrument approach after initiating action to retract the landing gear. Before the "go-around" procedure could be accomplished, the aircraft touched down on the runway with the landing gear in process of retraction. Indications are that the aircraft skidded on its "belly" approximately 2,000 feet before coming to a stop about 450 feet short of the end of the runway. The aircraft did not break up, the "keel" running the length of the fuselage giving the aircraft maximum impact resistance and absorbing most of the ground shock. The "belly" surface was damaged and the nose wheel gear door was ripped off. The two inboard turbine power plant pods were badly dam-

United Press International

An effective fire stop by the N. Y. International Airport fire crew saved this 707.

aged, but the integral wing fuel tankage was not seriously deranged.

Fire originated in the two inboard engines (Nos. 2 and 3) igniting a fuel spill under the forward center section of the fuselage. Source of the spilled fuel has not been reported. The fuel was Type A, kerosene.

The accident site was 2½ miles from the airport fire station. On arrival of fire equipment, about 4 minutes after the tower gave the crash alarm, the fire in the No. 3 turbine was attacked first with 350 pounds of foam-compatible dry chemical from the quick response unit which mounts a 500-pound dry chemical unit. Excellent results were achieved using only one handline. This was followed up with foam from one of the major foam units which completed extinguishment of the fire in the No. 3 turbine.

The second major foam unit was positioned on the port side to extinguish the fire in the No. 2 turbine and the spill fire under the forward center section of the fuselage. A total of 295 gallons of foam liquid concentrate and 2,950 gallons of water were used in thus securing the fire. The fire was knocked down in 5 minutes and total extinguishment secured within 10 minutes. The New York City Fire Department was called at 4:50 P.M. by the tower. They arrived at the airport at 5:12 and were escorted to the scene, but their services were not needed by this time.

As the aircraft skidded down the runway, the 3 stewardesses seated in the forward cabin were able to observe the fire in the area of the No. 2 engine and realized that emergency evacuation would be necessary. The 2 stewardesses in the attendants' seats in the aft cabin had only a limited view forward and were not immediately aware that an emergency existed.

The four flight deck crew members, the five stewardesses, and the 100 passengers (38 in the 48-person-capacity first-class forward fuselage section and 62 in the 68-person tourist-class aft fuselage section) evacuated the aircraft as the fire was being attacked.

May 23, Atlanta, Ga., Delta Air Lines Convair 880 $5,000,000; 4 killed

Local newspaper headlines following this accident read: "Fire Protection at Airport Hit"; "Fire Safety at Airport Examined"; "Only Two Firemen for Airport Crash"; "Airport Safety Standards are U. S. Responsibility."

The accident, occurring during a training flight with only four airline crewmen aboard the giant new Convair 880 just being introduced into domestic service, occurred at the western end of the east-west runway at the Atlanta Municipal Airport. Fire was instantaneous with the break-up of the fuselage and wings involving 10,000 gallons of the turbine fuel.

The only equipment at this big city airport for aircraft rescue and fire fighting service was a 1943 ex-Army Air Force crash truck (bought for $1.00 in 1946) and a jeep rescue vehicle carrying approximately 80 pounds of dry chemical, 150 pounds of carbon dioxide, and 100 gallons of water for foam production. The two firemen available drove these trucks to the scene, reaching it in about 7 minutes. There was, of course, no opportunity to perform any purposeful rescue effort or fire fighting activity with this manpower, this equipment, or after this period of time.

The NFPA at the 1960 Annual Meeting adopted revisions to our Suggestions for Aircraft Rescue and Fire Fighting Services for Airports and Heliports (No. 403). For

Atlanta Fire Dept.

A new "crash rig" purchased for the Atlanta Airport after the Delta Air Line Convair 880 crash.

aircraft of this size the revisions call for 9,000 gallons of water for foam production with 1,000 pounds of carbon dioxide or 300 pounds of dry chemical as supplementary agents. Since the accident, the airport has placed into service two new "crash" trucks, a major foam unit (see photo this page), and a 1,000-pound dry chemical unit to increase significantly the degree of protection available although the airport still does not fully meet the NFPA's suggestions. Manpower at the airport fire station has also been increased to 20 men, and a new fire house has been built at a runway intersection so that any part of the airport can be reached by responding equipment in under 2 minutes. The fire house has its own control tower on top of the building and a constant watch is maintained by a fireman on duty.

The 880 crash "cause" has been the subject of the usual Civil Aeronautics Board hearing, but their official report has not been released as yet. It would appear from newspaper reports of the hearing that evidence of the probable cause is largely conflicting. There are questions as to whether the 44-year-old pilot possibly had a heart attack during the take-off, why two of the starboard engines were possibly at idle speed (as the aircraft wreckage indicates) at the critical movements of climb after take-off, whether the instructor pilot (who had had two reported previous near-accidents on training flight take-offs) might have given the wrong advice or done the wrong thing if he took over the controls, and whether the 880 is a harder aircraft for pilots to learn to operate than other jet transports.

Aug. 12, Plattsburgh Air Force Base, N. Y., U. S. Air Force B–47E $778,000

Fire, which started at the rear main fuel cell in the fuselage, involved the fuselage back to the horizontal stabilizers but all three occupants of the cockpit of this B–47E were able to jump clear of the blazing aircraft as it came to rest on the overrun end of runway 17 at the Plattsburgh Air Force Base. Apparently the rear main gear was damaged when the aircraft touched down short of the runway. Friction sparks from subsequent skidding on the concrete runway are blamed for igniting the fuel vapors released when the fuselage fuel cell ruptured.

Fire apparatus responding to the 2:07 A.M. alarm included three O–11A's, two 1,000-gallon tankers, an R–2 rescue truck, and support equipment manned by 29 fire fighters. They used foam and carbon dioxide in the fire fighting attack and had the fire under control within 5 minutes. The loss is estimated at about 50 per cent of the total value of the aircraft (set at $1,861,667).

Sept. 14, LaGuardia Airport, N. Y., American Airlines Electra $2,300,000

A $2,300,000 Lockheed Electra, carrying 76 persons, made a routine final approach to New York City's LaGuardia Airport. The landing gear struck a 13-foot-high dike (7½ feet above the paved runway) on the approach end of Runway 31, and the aircraft next hit on its left wing, caught fire, rolled, and came to a grinding halt in an inverted position on the grass just off the runway. The final stopping point was about 925 feet from the point of original ground contact. The left wing broke on impact and the fire started immediately in that wing, flames streaming down the left side of the aircraft and leaving a scorched path behind the sliding aircraft.

None of the passengers and crew members were thrown from the aircraft or out of their seats during the deceleration of the aircraft or its subsequent inversion, indicating that the impact forces were actually quite low. All had their seat belts fastened. Many do not remember just how they unfastened or fell out of their seat belts and dropped to the ceiling (now the "floor" in the inverted aircraft) but all did so and none suffered any serious injuries. Most of the passengers left through the lounge emergency exit on the right side of the aircraft which had "sprung" slightly during the crash and was easily opened by the stewardesses who had been sitting in the lounge during the landing. Some passengers escaped via the buffet service door on the left side after it had been opened by two airline mechanics who raced to the scene on a tractor and who extinguished some ground fire in the area with a hand carbon dioxide extinguisher. At least a dozen passengers left via an emergency window exit on the right side. This exit normally would have brought them out over the right wing, but, with the aircraft inverted, they had only a short step to the ground. The crew members escaped through a side, sliding window in the cockpit after a passenger rushed forward after escaping and operated the emergency pull handle exterior release from the outside using a coin to dig out dirt which prevented his original efforts to grasp the release.

The arrow points to the lounge door on this Electra which crashed at La Guardia Airport, Sept. 14. This door was the principal exit used by the majority of the 76 who escaped.

The evacuation was accomplished without panic and with surprising ease. The ceiling of the aircraft (used as the "floor" during the evacuation) was unobstructed by seats, there was sufficient daylight in the aircraft to see, and the step-up to the exit openings inside the inverted aircraft and the step-down to the grass were short and easy to accomplish. No fire existed at the lounge exit on the right side and there was no fire within the fuselage at the time.

Emergency equipment at the airport responded to the unanticipated accident on an alarm from the FAA Tower. Two major units of foam equipment, a "nurse" (water tanker) truck, and a dry chemical unit responded from the airport fire station manned by 10 fire fighters and 4 rescue men. It is estimated that the first unit reached the scene in 2½ minutes from the time of the alarm (9:02 A.M.). Mutual aid assistance (prearranged) came from the NYC Fire Department (3 engine companies, 3 truck companies, and 1 foam unit manned by 14 fire fighters), the first units arriving in about 9 minutes. Although the actual accident occurred at 9:00 A.M. (EDST) and the weather was clear, accumulation of rain water in the grassy area bogged down one of the city fire trucks, indicating the importance again (see April 1960 QUARTERLY, page 408) of off-highway vehicle performance of airport crash equipment. The airport equipment had no trouble.

Foam was the principal fire-extinguishing medium. Fire fighters used 690 gallons of liquid foam concentrate plus 430 pounds of chemical foam powder. The kerosene fuel fire was extinguished in about 4 minutes, but magnesium-fed flames in the nose sections of the Nos. 3 and 4 engines burned until the metal was consumed while fire fighters kept these fires under control with dry chemical initially and then within termittent foam application. Water fog was used on smoldering seat cushions and the slight grass fire. Water for the early firefighting was the 2,000 gallons in the two major crash trucks and 2,500 gallons in the nurse truck. Subsequently, water was relayed from a sprinkler riser in a rampside hangar through 2,000 feet of hose using 4 engine companies in the relay operation.

The aircraft had an estimated 2,090 gallons of Type A (kerosene) turbine fuel aboard at the time. When the landing gear struck the dike, the left gear ripped out the front spar of the left wing-root tank which was about ½ full. Before the plane struck the ground, the lower half of the fuselage aft of the wing and up to the base of the fin was bathed in a kerosene spray atomized by the 120-knot air stream. Ignition occurred from one of a number of sources, most probably the exhaust from the No. 2 engine During this time, some of the occupants were conscious of the heat radiated through the windows and saw the flames streaking past.

After the aircraft came to rest, some of the kerosene fuel was still spilling from the left wing stub and from the major portion of the tank which remained with the left wing and which separated from the fuselage. There was some fuel on the water-saturated surface of the sod burning mildly along the fuselage contact line but most of this burned up in less than two minutes. There was burning in the broken-off left wing; most of the inboard tank's fuel had been spilled as noted earlier but the outboard tank was running fuel and burning. The inverted right wing outboard tank had ruptured and was running fuel which was burning in that area.

The inboard right wing tank was intact and about six barrels of kerosene were subsequently pumped out of it prior to moving the fuselage.

Four passengers sitting in the vicinity of the overwing emergency exits received burns of varying degrees, apparently because the left emergency exit popped open during the twisting of the fuselage as it skidded over the ground and flames were coming in this exit as the aircraft came to rest. With the aircraft inverted, the overwing exit was underneath the wing and subject to the fires burning in the wing areas. Fire entering the cabin through this window opening started an internal cabin fire. Whether the internal fire damage would have been as severe as it was if other windows had not been broken in by firemen is a question.

The question has been raised as to whether with aviation gasoline or Type B turbine fuel (gasoline-kerosene blends of the JP–4 type), the story of the escape of the 76 occupants would have been substantially different. From the analysis given of the fire's behavior, it would not seem that there would have been a great deal of difference in this particular accident. The worst spill was along the skid wake and not where the aircraft came to rest. The fuel spilling from the inverted wings was all on the right side downwind from both rear exits that were used. There was not enough additional fuel along the fuselage on the water-covered ground to create a holocaust.

Arrow at top indicates the dike which the aircraft hit, and arrow at aircraft shows the location of the lounge door which was the principal exit means for the passengers. The Electra caught fire after it hit the dike but flames did not bar escape of all aboard.

Air Force

All the crash rescue and fire fighting equipment available at this major Air Force Base could not be used successfully to extinguish this burning B-52D on December 15. Fortunately, however, the major mission, rescue, was accomplished.

Dec. 15, Larson Air Force Base, Wash., U. S. Air Force B–52D $8,007,000

After sustaining structural damage to the right wing in flight during an air-borne refueling accident, this B–52D with 10 crew members aboard made an emergency landing at the Larson Air Force Base at 11:23 A.M. With advanced knowledge of the emergency landing, giant fire fighting forces were mobilized in the event they were needed and subsequent events testified as to their value with 10 lives saved. As can be typical, however, the aircraft was a total loss from the resultant crash fire and it was even necessary to withdraw fire fighting forces for a time after the rescues were accomplished because of the severity of the fire and the explosions which ensued. One of these explosions caused considerable fire damage to an R–2 rescue truck which was showered with burning fuel while positioned off the left wing.

The prearranged plans resulted in massing the following equipment for the rescue effort:

Type O–11A	5 units
Type O–10	2 units
Type O–6	1 unit
Water tank trucks	2 units
Pumpers	4 units
R–2 rescue truck	1 unit
Helicopter and fire suppression kit	1 unit
Dry chemical truck	1 unit

To man this equipment, 73 fire fighters were available from the Air Base alone with additional personnel from the Boeing Flight Center Fire Department which supplied seven of the seventeen units of fire equipment. In addition a de-icer boom and a crash crane were positioned at the runway intersection to be used for rescue if needed.

This is the first time that it has been possible to report in the NFPA QUARTERLY of an actual crash incident where a helicopter (in this case an H–43B) was used as a fire control unit. Normally these units would be used for "off-airport" crashes where access to the accident site might be difficult or impossible for land based, vehicular equipment. In this case, the helicopter was used along with major units of crash equipment deployed on both sides of the burning B–52 in the center of the runway.

The helicopter carried two fire fighters to the scene and then hovered over the nose of the burning aircraft using the rotor air blast to drive flames and burning fuel away from the escape hatches in the cockpit area while the nine occupants of that section made their escape. While this was going on, foam from the turrets and handlines from four of the O–11A's and carbon dioxide from the boom and hose lines of the O–6 opened a rescue path through which the crew could escape. The tail gunner jettisoned his turret and leaped to the ground. Injured, he was then aided from the danger area. Only one of the crew and one fire fighter sustained any burns, all fire fighters wearing conventional USAF protective clothing.

The fire originated in the damaged right wing section of the B–52D, which had been punctured by the refueling boom of a KC–135 jet tanker in flight and then collapsed as the eight-turbine-engined bomber rolled down the runway. (The KC–135 made a safe landing at its home base.) A fuel-vapor explosion occurred engulfing the entire B–52D as the crash equipment got into position. Despite the massive fire fighting attack the flames went out of control after the rescues were accomplished and subsequent explosions made continuous fire control activity impossible for a period of time (see photo). Subsequently, as safety to fire fighting personnel permitted, fire extinguishment activity was recommended and the fire was extinguished shortly after noon. The O–11A's were serviced at the scene by water tank trucks (total capacity 4,000 gallons) and by flat-bed trucks used to transport the additional foam liquid concentrate needed. In all some 1,300 gallons of foam liquid, 13,000 gallons of water, and 4,000 pounds of carbon dioxide were used.

Fires in Flight

Five of the seven in-flight fire incidents, all involving military aircraft, are briefly reviewed herein. The sixth incident was reported in the January 1961 QUARTERLY, page 253 and involved a Navy P5M over Puget Sound, Washington, February 11. The seventh was also a Navy aircraft lost off the California Coast on April 15 (no further information available).

Mar. 28, San Diego, Calif., U. S. Navy AD–6 Skyraider $250,000, 1 killed

Having the right equipment and personnel available and securing optimum utilization of them does not always guarantee success. The pilot of this AD–6 was dead when reached, but his removal was done effectively despite the following conditions:

1. Response of equipment to the off Air Base crash site took 3 minutes, 15 seconds after the crash alarm;

2. The pilot's legs were jammed between the rudder pedal and the accessory instrument pedestal in the cockpit forcing the use of tools to break away the pedestal from its mounting to free the trapped pilot;

3. On arrival fire engulfed the cockpit area and had to be knocked down before rescue entry could be made;

4. The plane had crashed into a shallow pond of water and burning fuel spread over a 5,000 sq. ft. area around and to the rear of the aircraft, handicapping fire control efforts.

The crash alarm at the North Island Naval Air Station was sounded when the tower reported that the AD–6 had an engine fire in flight and would not make the field. Equipment proceeded to the approach end of Runway 29 which the aircraft was attempting to reach and upon arrival saw that the plane had crashed on Coronado Beach approximately 4,000 ft. short of the runway. The equipment on response continued down the access road off the end of the runway and through the perimeter fence gate to the scene while other Air Base equipment responded via city streets to the crash site in the event the other units could not reach the scene and to act as back-up for the first units if needed.

U. S. Navy

Fire in flight preceded this crash fire of an AD-6 in San Diego. A difficult rescue effort was made by Naval Air Station fire fighters under severe fire exposure conditions.

Arrival of the three first units (Navy types MB–5, O–6, and MB–1) at the site was about 3 minutes, 15 seconds after the crash alarm. The MB–5 (a foam unit) lined up on the nose of the aircraft and foamed the area around the cockpit. A rescue man from the MB–5, the Crash Chief, and a Crash Captain went to the cockpit to commence rescue operations. The O–6 (a low-pressure carbon dioxide truck) took position on the left side of the MB–5 and applied carbon dioxide on the fire area intermittently to keep flames away from the cockpit, made even more difficult by the pond of water on which burning fuel was floating. A rescue man from the O–6 joined in making the rescue effort. The MB–1 (the Navy's major foam unit) took position on the right side of the MB-5 and applied foam over the entire fire area. A fifth rescue man by this time was available from the MB–1 to aid in removing the trapped pilot. By using this "combined agent technique" of crash fire control recommended in the NFPA's Suggestions for Aircraft Rescue and Fire Fighting Services for Airports and Heliports (No. 403) and by having the trained rescue personnel available, the trapped pilot was reached and removed expeditiously. It is estimated that the cockpit was cleared of fire within 5 seconds after arrival of the first crash truck.

After the pilot was removed, the entire burning area was foamed and the fire extinguished. This meant covering the water-borne fuel over a 5,000 sq. ft. area around and to the rear of the aircraft. In the fire fighting effort, 1,450 gallons of water, 90 gallons of foam liquid concentrate, 4,600 pounds of low-pressure carbon dioxide, and 300 pounds of dry chemical were used. It is estimated that about 300 gallons of aviation gasoline was involved in the fire.

June 27, near Bethel, Maine, U. S. Air Force KC–97G $1,200,000; 5 killed

A material failure of the Number One engine turbo supercharger with ensuing fire caused loss of control of a KC–97G while in flight. With its cargo of 25,000 pounds of JP–4 jet fuel and some 39,000 pounds of aviation gasoline in its wing tanks the aircraft fell in flames crashing in a wooded area about nine miles north of Bethel, Oxford County, Maine. All five of the crewmen aboard were killed. No rescue operations were possible.

It is reported that when the failure of the turbo occurred, fragments severed fuel sources causing the in-flight fire. The accident occurred during a night training exercise in good weather.

July 12, near Clewiston, Fla., U. S. Air Force B–47B $2,500,000

A turbine wheel failure in the Number 4 engine started an in-flight fire in the Numbers 4 and 5 engine nacelles which spread to the fuselage and required ejection of the crew members at 10:05 P.M. Two members were picked up promptly by local civilians and Coast Guard helicopters. The third, an instructor pilot, was partially incapacitated, but was picked up by a search party at dawn after spending the night in a dinghy. The aircraft crashed in a swampy, level area of the Everglades. There was no attempt made to control or extinguish the ground fire due to the lack of fire fighting equipment in the area and the nature of the terrain where the wreckage fell.

The in-flight emergency came suddenly as the B–47B was proceeding in straight and level flight following an air-borne refueling operation over the Gulf of Mexico. Fire was instantaneous with turbine wheel failure. Emergency procedures were initiated and the Nos. 4, 5, and 6 engines shut down. At this time radio communication was lost and electrical and hydraulic lines were severed. The fire "buttons" to the 3 engines were pulled, but the effect was negative since the electrical power to actuate the systems was dead. Other aircraft in the area saw the flaming aircraft in descent and relayed position and time to the Miami Center, which, in turn, dispatched the Coast Guard to the scene. The aircraft had 65,000 pounds of JP–4 fuel aboard at the time of the emergency.

July 14, near Bracketville, Tex., U. S. Air Force, U–2 over $1,000,000 (Confidential)

The pilot of a U–2, the same type of high altitude reconnaissance plane used by Francis Powers in his flight over Russia, was forced to parachute from his aircraft following a fire which started in the cockpit area. The aircraft exploded soon after the pilot evacuated and parts of the aircraft were spread over a two mile area in rocky, wooded country near Bracketville, Texas. The pilot was rescued and suffered only a few bruises.

Few details are available due to the classification of the aircraft, but seventy-five per cent of the loss is attributed to the fire and the air-borne explosion. Fire fighters from the Laughlin Air Force Base responded to the emergency but had to travel fifty-five miles. Access to the crash site was made difficult by the terrain conditions. By the time they arrived, the fire was out.

July 19, near Daufuskie Island, S. C., U. S. Navy HSS–IN $750,000; 3 killed

Three HSS–IN helicopters were cruising at 600 feet when the pilots and crews of two of the helicopters saw the leader's aircraft on fire. The big ship started to descend and then slowly to disintegrate. It struck tree tops in a nearly inverted position and crashed in flames in a remote area. There was no radio transmission from the lead aircraft during the descent. By the time rescue aircraft could reach the scene, the aircraft had been consumed by fire and there were no survivors among the three crewmen aboard.

It was difficult to determine the exact cause of the air-borne fire although all available evidence indicates that the most probable cause was failure of the engine cooling fan, followed by rupture of fuel lines in the engine compartment. The HSS–IN does not have a fire extinguishing system aboard to protect itself against this type of air-borne engine fire.

Ground Fires

There were seven ground fire incidents. The three summarized are each unique in themselves, one involving a Bomarc missile, one an F–86H during engine starting on the ramp, and the third resulting from a taxiing incident with a DC–7C. There were two other missile accidents, both at Vandenberg Air Force Base, occasioned from accidental fires during fuel handling of an Atlas and a Titan on March 6 and December 3 respectively. Technical data have not been released on either incident to date. The X–15 accident at Edwards Air Force Base on June 8 seems likewise to be clothed in security restrictions. The seventh incident occurred at Fairchild Air Force Base on April 1 and involved a B–52. Apparently the bomber was idling for takeoff when a fire occurred and the aircraft was destroyed, but again the NFPA has not been able to verify newspaper accounts or get the full technical information.

June 7, McGuire Air Force Base, N. J., U. S. Air Force, Bomarc Missile and Shelter Over $1,000,000

A Bomarc (IM–99A) missile was in what the Air Force calls a "ready storage condition" on its launcher within a launch shelter and armed with a nuclear warhead when this explosion occurred. The fire which resulted caused the loss of the missile and severe damage to the shelter. There were no personnel injuries and no damage to adjacent similar launch shelters.

A "ready storage condition" means that the Bomarc was, at the time of the accident, so armed and fueled to be fully operable for its Air Defense mission; the propellant tanks were loaded, the high pressure gas containers filled to their maximum operational pressure, and the warhead attached. This meant that on board the missile were substantial quantities of red fuming nitric acid, JPX, 80-octane gasoline, aniline, unsymmetrical dimethyl hydrazine and helium under pressure as well as the nuclear warhead itself.

Launch shelters for these missiles are constructed of thick reinforced concrete walls with unprotected steel movable roof structures. This particular structure was about 1,700 square feet in area. They are designed to withstand the blast and contain any fire which could result from an explosion of the type which occurred without exposing adjacent shelters to blast or fire effects. Without losing sight of the financial loss and the serious public reaction caused by this accident, it is reassuring to note that the shelter performed in a highly satisfactory manner, confining the blast and fire to the inside of the structure.

The warhead burned and melted harmlessly on the floor of the shelter and did not cause any harmful radiation. Fire fighters who responded to the scene were initially held from fighting the fire for 15 minutes by the Missile Safety Officer until the area was checked for any possible radiation hazard. Then, equipped with fuel handlers' gear and self-contained breathing apparatus, they advanced with hose lines to put water into the shelter. The area was constantly checked for radiation hazards as firemen moved in. The hose lines did wash a portion of the melted warhead residue a few feet out of the open door but this was the limit of any radiation spread and that was only a low energy alpha emission. During the fire fighting, the water served as an effective shield against this radiation.

Wide World

Airview of the launching shelter at McGuire Air Force Base following the fire in a Bomarc missile stored in a "ready condition" therein. The fire resulted from the rupture of a helium tank which caused impact damage to the missile's fuel and chemical lines.

Oddly and ironically, the basic cause of the accident was not chargeable to any of the highly flammable components of the missile but to the rupture of the tank containing helium, a nonflammable gas. The tank failure ruptured the missile's fuel and chemical lines resulting in the intense fire. It has been explained by the Air Force that a missile is a "one shot" vehicle and each pound of excess weight has a noticeable effect on performance. As a result, the design of the helium tanks does not incorporate the same overstrength safety factors common to other pressure cylinders used in industry and in aircraft The helium tanks are designed with only a 1.25 safety factor in this usage. Examination of the tank showed that the metal was not of exact uniform thickness in all areas and it is reasoned that failure occurred as the result of low-cycle maximum stress from loading to the operational pressure an undetermined number of times. A reevaluation of the helium systems of these missiles was ordered as a result of this accident and lower pressures used until an inspection could be made of all helium tanks.

The accident caused some widespread public alarm for a number of hours as rumors spread that an atomic warhead had been involved and that a radiation peril existed over a wide area. Some lack of coordination was charged by Civil Defense authorities who were not promptly advised as to what had occurred. State Police were told by or interpreted a message from the Air Base to the effect that an atomic warhead had exploded and they blocked roads for an 8-mile radius until they could be assured that no hazard existed. Within this radius was Jackson Township, a community of 3,500 persons.

Sept. 11, Andrews Air Force Base, Md., U. S. Air Force, F–86H $582,500

A starter exploded while the pilot was attempting to start this F–86H parked on a concrete ramp at the Andrews Air Force Base. The failure ruptured fuel tanks and the main fuel line to all tanks resulting in a severe fire which involved the 2,659 gallons of fuel aboard very quickly. An immediate box alarm brought 7 major units of crash equipment (Type O–11B and O–11A), manned by 31 fire fighters, to the scene in front of the National Guard hangar. The plane was fully involved by the time equipment could arrive in 3 minutes time.

Fire fighting was with turret and hose streams from the foam units. Rapid control was achieved with 200 gallons of foam liquid concentrate. Chlorobromomethane was used to secure extinguishment in the wheel well area. One fire fighter was temporarily overcome by the CB fumes, but was treated and released promptly. The pilot escaped from the aircraft unaided. Another airman received minor injuries from the flying parts when the explosion occurred.

Sept. 14, Love Field, Dallas, Tex., Braniff Airways, DC–7C $712,000; 1 killed

A Braniff DC–7C was being taxied from the ramp to a taxiway for a "run-up" after com-

pletion of some maintenance work. An inspector, acting as pilot, was in charge of the operation and eight other mechanics were aboard. As the aircraft was being turned onto the taxiway, loss of hydraulic pressure occurred and the aircraft, with all four engines operating, went out of control. It then struck the Braniff hangar traveling at an estimated taxi speed of 10 to 15 miles per hour. A twelve-inch "I" beam, part of the hangar canopy, cut through the cockpit penetrating some 15 feet into the fuselage and cutting cockpit control panels loose. This caused the engines to run wild and to trap those in the cockpit. At about this time one engine caught fire as the result of damage to that engine from the collision with the hangar and the subsequent release of oil sprayed on adjacent hot engine parts.

An alarm was received by the Dallas Fire Department at 3:47 P.M. and the first equipment to reach the scene arrived at 3:49. Calls were immediately sent for help and particularly for ambulances, doctors, and wrecker equipment. The fire was attacked immediately by the airport rescue unit, and within two minutes the fire was smothered by foam. None of the estimated 10,000 pounds of fuel aboard the DC–7 became involved. Braniff mechanics in the area quickly mobilized to stop the engines, being forced to work in the engine nacelles to accomplish this objective since the cockpit controls had been rendered useless.

Of the nine men aboard the aircraft at the time of the accident, two escaped unaided and uninjured. The other seven had to be rescued by the joint efforts of the Fire Department and Braniff personnel. It was necessary to cut a hole in the fuselage and to raise the control panels with a cable and winch of a boom-equipped wrecker rushed to the scene under police escort. Other injured were removed by the use of fire department and shop power tools. The acting pilot was the only one to receive fatal injuries. The total rescue effort took about an hour and forty-five minutes.

Other 1960 Aircraft Disasters

There were a number of other serious aircraft crashes in the United States during 1960 where fire followed impact but the losses are mainly attributable to other basic factors. Included for special mention are the following:

Jan. 6, near Bolivia, N. C., National Airlines, DC–6B, 34 killed. A dynamite explosion (passenger-caused) in flight; aircraft burned on impact.

Jan. 18, near Holdcraft, Va., Capital Airlines, Viscount, 50 killed. Power loss in flight followed by near vertical descent; aircraft burned on impact.

Mar. 17, near Tell City, Ind., Northwest Airlines, Electra, 63 killed. Structural failure in flight followed by near vertical descent; aircraft burned on impact.

Oct. 28, near Frenchtown, Mont., Northwest Airlines, DC–4, 12 killed. Crashed into mountain at flying speed; aircraft burned on impact.

In the January 1961 QUARTERLY there appears on page 258 a listing of 1960 major aircraft disasters in other countries.

Table II

List of 1960 Large Loss Fires by Occupancies

An asterisk (*) before the date indicates that the fire spread to other buildings. A dagger (†) before the date indicates an other than building fire. The (nc) in the insured indirect loss column indicates that as far as can be determined the property involved was *not covered* by indirect loss insurance. Fires written up in this and other issues of Volume 54 of the QUARTERLY are listed in the Index to Volume 54 published in this issue.

The Large Fires in Places of Public Assembly — 1960

	Total No. of Fires	Total No. Killed	Total No. Injured	Total Property Damage Loss In Thousands	Total Insured Indirect Loss In Thousands
U. S. Losses	31	4	74	$14,579.0	$614.0
Canadian Losses	7	1	36	2,755.0	0
Total Losses	38	5	110	$17,334.0	$614.0

Date	Place and Occupant	No. Dead	No. Injured	Property Damage In Thousands	Insured Indirect Loss
	Amusement and Recreation Places				
Jun. 25	Lowell, Mass., Rex Amusement Center	..	7	$827.5	$28.0
Dec. 17	Louisville, Ky., Parkmoor Recreation Center	3	12	760.0	nc
	Armories				
Jan. 23	Prescott, Ont., Prescott Armouries	..	..	500.0	nc
Mar. 18	Vancouver, B. C., Stanley Park Armoury	..	2	355.0	nc
	Auditoriums				
Mar. 23	Steelton, Pa., United Steel Workers Union Quarters	..	3	250.0	nc
	Bowling Alleys				
Feb. 15	Buffalo, N.Y., Roc-Mar Bowling Alleys	..	..	260.0	..
Mar. 6	Niles, Mich., White's Bowling Lanes	..	..	250.0	..
Mar. 13	Volney, N.Y., Tony Fedora Bowling Alleys	..	..	300.0	..
Aug. 12	East St. Louis, Ill., Playdium, et al	..	3	270.0	nc
	Churches				
Jan. 23	Rochester, N.Y., Temple Beth-El	..	2	250.0	nc
Feb. 12	Gainesville, Ga., First Baptist Church	..	..	600.0	nc
Mar. 10	Philadelphia, Pa., Bethany Temple Presbyterian Church.	..	3	322.5	nc
Mar. 31	Canandaigua, N.Y., First Methodist Church	..	2	300.0	nc
*May 6	Mulgrave, N.S., St. Lawrence Church, et al	..	..	250.0	nc
Jun. 10	Sumter, S.C., Trinity Methodist Church	..	..	500.0	nc
Sep. 7	Waterbury, Conn., Second Congregational Church	..	1	760.0	nc
Dec. 9	Victoria, B.C., St. John's Church	..	..	265.0	nc
*Dec. 22	Anderson, Ind., First Methodist Church, et al	..	..	426.0	0.5
	City Clubs				
Feb. 28	Findlay, Ohio, YMCA Bldg.	..	1	300.0	nc
Mar. 26	Butte, Mont., Butte Public Library Club Room	..	..	321.0	nc
	Country Clubs				
May 16	Ste. Marguerite Station, P.Q., Deauville Estates, Ltd.	..	1	269.0	..
Jul. 2	Haverhill, Mass., Haverhill Golf & Country Club, Inc.	..	6	250.0	..
Sep. 5	Greenwich, Conn., Greenwich Country Club, Inc.	..	4	1,105.0	nc
	Exhibition & Exposition Halls				
Sep. 7	Springfield, Mo., Ozarks Empire Fair Association	..	..	250.0	nc

Table II — Continued

Public Assembly Fires (Cont.)

Date	Place and Occupant	No. Dead	No. Injured	Property Damage In Thousands	Insured Indirect Loss
	Historical Buildings				
Aug. 1	near Francisville, La., Greenwood Plantation	..	..	250.0	nc
	Motion Picture Theaters				
Feb. 14	Blue Island, Ill., Lyric Theater Bldg., et al	..	1	372.0	..
Oct. 26	Pontiac, Mich., Oakland Theater, et al	..	3	415.0	..
	Night Clubs				
Jun. 17	near Las Vegas, Nev., El Rancho Vegas	..	1	1,060.0	500.0
Sep. 13	Cleveland, Ohio, Theatrical Grill, Inc.	..	2	250.0	Yes
	Outdoor Public Assembly				
†Apr. 17	Memphis, Tenn., Russwood Baseball Park	..	8	1,097.5	1.5
	Restaurants				
Apr. 21	Patchogue, N.Y., Felice's Restaurant	1	..	350.0	..
Jun. 4	Whitman, Mass., The Old Blacksmith Shop Restaurant	..	1	291.5	11.0
*Aug. 11	Du Bois, Pa., B & J Restaurant, et al	..	3	729.0	..
Sep. 6	Albany, N.Y., Wander Building	..	7	556.0	73.0
*Oct. 22	Quebec, P.Q., Beaver Restaurant, et al	..	30	490.0	..
*Nov. 14	London, Ont., Belmont Restaurant, et al	1	3	626.0	..
Dec. 2	New Orleans, La., Glucks Restaurant	..	4	606.0	..
*Dec. 12	Wildwood, N.J., Zaberer's Holiday Restaurant	..	..	300.0	..

The Large Educational Building Fires of 1960

	Total No. of Fires	Total No. Killed	Total No. Injured	Total Property Damage Loss In Thousands	Total Insured Indirect Loss In Thousands
U. S. Losses	14	1	41	$5,243.5	$0
Canadian Losses	2	0	0	740.0	0
Total Losses	16	1	41	$5,983.5	0

Date	Place and Occupant	No. Dead	No. Injured	Property Damage In Thousands	Insured Indirect Loss
	Private Boarding Schools				
Mar. 10	Philadelphia, Pa., Overbrook School for the Blind	1	6	$400.0	..
	Private Day Schools				
Feb. 19	Pittston, Pa., St. John's School	..	2	393.5	nc
Apr. 17	Camden, N.J., Camden Catholic High School	..	..	400.0	nc
	Public Schools				
Feb. 16	York Twp., Ont., Rawlinson Public School	..	..	325.0	nc
Feb. 17	Empire, Oreg., Michigan Ave. School	..	1	341.0	nc
*Mar. 10	Gloucester City, N.J., Gloucester City Board of Education	..	..	303.0	nc
Mar. 19	Wauseon, Ohio, Clinton Street School	..	6	700.0	nc
Mar. 21	Shelby County, Tenn., Barretts Chapel School	..	..	260.5	nc
May 8	Lewis, Iowa, Lewis Community School Dist.	..	..	330.0	nc
May 29	Mitchell, Ind., Mitchell High School	..	..	260.0	nc
Aug. 28	Winslow, Ariz., Winslow High School	..	2	305.5	nc
Oct. 29	Salt Lake City, Utah, Lowell Elementary School	..	1	250.0	nc
Nov. 18	near Memphis, Tenn., Ford Road Elementary School	..	6	250.0	nc
Nov. 26	Kennetcook, N.S., Hants North Rural High School	..	..	415.0	nc
Dec. 1	Winston-Salem, N.C., Fairview Elementary School	..	..	400.0	nc
Dec. 12	Eddystone, Pa., Eddystone Grade and High School	..	17	650.0	nc

Table II — Continued

The Large Institutional Building Fires of 1960

	Total No. of Fires	Total No. Killed	Total No. Injured	Total Property Damage Loss In Thousands	Total Insured Indirect Loss In Thousands
U. S. Losses	4	0	16	$1,557.0	$0
Canadian Losses	0	0	0	0	0
Total Losses	4	0	16	$1,557.0	0

Date	Place and Occupant	No. Dead	No. Injured	Property Damage In Thousands	Insured Indirect Loss
	Hospitals				
Dec. 31	Port Arthur, Tex., Park Place Hospital, Inc.	..	..	$250.0	nc
	Mental Institutions				
May 20	Northampton, Mass., Northampton State Hospital	..	13	350.0	nc
Oct. 24	Central Islip, N.Y., Central Islip State Hospital	..	3	510.0	nc
	Penal Institutions				
Jul. 26	near Nashville, Tenn., Tennessee State Penitentiary	..	..	447.0	nc

The Large Residential Building Fires of 1960

	Total No. of Fires	Total No. Killed	Total No. Injured	Total Property Damage Loss In Thousands	Total Insured Indirect Loss In Thousands
U. S. Losses	16	0	38	$7,130.0	$37.0
Canadian Losses	3	1	8	1,151.0	0
Total Losses	19	1	46	$8,281.0	$37.0

Date	Place and Occupant	No. Dead	No. Injured	Property Damage In Thousands	Insured Indirect Loss
	Apartments — No Mercantile				
Dec. 24	Garden City, L.I., N.Y., Garden Court Apartment Building	..	..	$300.0	..
	Apartments — With Mercantile				
Feb. 2	Kitchener, Ont., Maher Shoes, et al	..	8	361.0	..
Mar. 17	Braddock, Pa., Bishoff Bldg.	..	1	300.0	..
Nov. 12	Malden, Mass., Gould Building	..	14	250.0	..
	Dwellings				
Feb. 4	Roslyn Harbor, N.Y., Dr. Wendell Hughes	..	..	250.0	nc
Jul. 4	Lafayette, Calif., John P. O'Shea	..	..	250.0	nc
*Sep. 30	Harewood & Nanaimo, B.C., 35 Buildings	..	..	300.0	nc
	Fraternity & Sorority Houses				
Aug. 23	Stanford, Calif., Phi Gamma Delta Fraternity House	..	..	250.0	nc
	Hotels				
	Continuous Operation				
*Jan. 27	Minot, N.Dak., Grand Hotel	..	2	450.0	12.0
*Jan. 30	Gettysburg, Pa., Adams House, et al	..	1	255.0	nc
Mar. 2	Eugene, Oreg., Hoffman Hotel	..	4	250.0	nc
Jul. 16	Fort Nelson, B.C., Fort Nelson Hotel, Ltd.	1	..	490.0	..
Oct. 9	Williamson, W.Va., Mountaineer Hotel	..	..	250.0	Yes
Dec. 15	Austin, Tex., Commodore Perry Hotel	..	..	300.0	25.0

Table II — Continued

Hotels (Cont.)

Date	Place and Occupant	No. Dead	No. Injured	Property Damage in Thousands	Insured Indirect Loss
Seasonal Operation					
Feb. 1	Alexandria Bay, N.Y., Pine Tree Point Club	..	..	250.0	..
Mar. 14	Atlantic Beach, N.Y., Nautilus Hotel	..	5	2,800.0	..
*Mar. 23	Atlantic City, N.J., Hotel Wiltshire, et al	..	11	300.0	..
Jun. 7	Ellenville, N.Y., Sunrise Manor	..	..	375.0	Yes
Sep. 24	Beach Haven, N.J., Hotel Baldwin	..	..	300.0	..

The Large Mercantile Building Fires of 1960

	Total No. of Fires	Total No. Killed	Total No. Injured	Total Property Damage Loss In Thousands	Total Insured Indirect Loss In Thousands
U. S. Losses	52	0	104	$21,449.0	$1,159.5
Canadian Losses	7	12	92	3,347.5	266.0
Total Losses	59	12	196	$24,796.5	$1,425.5

Date	Place and Occupant	No. Dead	No. Injured	Property Damage In Thousands	Insured Indirect Loss
	Appliance Sales				
Nov. 7	Gary, Ind., Shoppers Fair of Indiana, Inc.	..	1	$995.0	$260.0
	Auto Supply Stores				
Mar. 5	Winter Haven, Fla., Firestone Automotive & Appliance Co.	..	1	250.0	..
	Barber and Beauty Shops				
Dec. 25	Lakewood, Ohio, Vivians Beauty Parlor, et al	..	2	287.0	30.0
	Book Stores				
*Jan. 31	Hull, P.Q., Joseph La Flamme & Sons, et al	..	7	350.0	..
	Cigar Stores				
Oct. 30	St. Joseph, Mo., Ben Eveloff Cigar Store, et al (Logan Bldg.)	..	..	329.0	65.0
	Clothing Stores				
May 17	Rome, Ga., H. Kessler and Company	..	..	375.0	..
May 17	Hackensack, N.J., Oppenheim Collins Co., Inc., of N.J.	..	11	275.0	..
May 27	Harrisburg, Pa., Youth Center, et al	..	3	1,200.0	..
*May 29	Joliette, P.Q., J. Sansoucy, et al	..	2	270.0	..
	Department Stores				
May 11	near Jacksonville, Fla., Atlantic Mills Thrift Center	..	2	525.0	..
Ju n. 21	Fort Dodge, Iowa, Gambles Dept. Store	..	2	371.5	nc
Jul. 4	Kansas City, Mo., Employees Consumer Organization, Inc., et al	..	6	1,572.0	250.0
Aug. 30	Ann Arbor, Mich., Montgomery, Ward & Co.	..	..	275.0	..
*Aug. 31	Harrisonburg, Va., Bargain Shop, et al	..	3	315.0	..
Sep. 26	Vancouver, B.C., Hamilton Harvey & Sons, et al	..	5	878.5	..
Oct. 25	Windsor, Ont., Metropolitan Stores, Ltd.	10	75	555.5	..
	Drug Stores				
Jan. 22	New Canaan, Conn., Lang's Pharmacy	..	..	500.0	nc
Feb. 5	New York, N.Y., Forest Hills Pharmacy	..	1	500.0	..
	Florist Shops				
*Jan. 25	Ketchikan, Alaska, Tom Sawyer Flower & Gift Shop, et al	..	2	408.0	17.5
	Food Stores, General				
Dec. 27	Highland Park, Ill., Ruby's Delicatessen	..	1	304.0	76.0

Table II — Continued

Mercantile Buildings (Cont.)

Date	Place and Occupant	No. Dead	No. Injured	Property Damage In Thousands	Insured Indirect Loss
	Furniture Stores				
Feb. 15	Memphis, Tenn., Demuth Furniture Co.	..	..	335.5	10.5
Oct. 12	Sacramento, Calif., Capitol Office Equipment Co.	..	..	300.0	Yes
Dec. 9	Kokomo, Ind., Leath Furniture Co.	..	..	331.0	50.5
	Hardware Stores				
Jan. 5	Moncton, N.B., Moncton Plumbing & Supply, Ltd.	1	..	291.5	266.0
*Jul. 10	Cynthiana, Ky., L.C. McLoney & Son, et al.	..	4	300.0	nc
*Aug. 26	San Rafael, Calif., O'Neill & Logan Hardware Co., et al.	..	5	437.0	nc
	Heavy Equipment Sales				
Mar. 2	Minneapolis, Minn., Sears, Roebuck and Co.	..	..	275.0	nc
	Jewelry and Gift Shops				
Apr. 11	Huntington, W.Va., Rogers Jewelers et al.	..	5	373.5	..
Nov. 7	Fremont, Calif., International Kitchen Pottery Shop, et al	..	..	250.0	..
	Marine Salesrooms				
May 11	Buffalo, N.Y., Marine Sales Co., et al.	..	3	250.0	..
	Music Stores				
Dec. 31	St. Joseph, Mo., Eshelman-Music Co., et al	..	..	508.0	86.0
	Self-Service Food Stores (less than 10,000 sq. ft.)				
*May 7	Oxford, N.Y., Great Atlantic & Pacific Tea Company, et al	..	..	500.0	..
Nov. 7	Toronto, Ont., Loblaw Groceterias, Ltd.	1	3	567.0	..
	Shoe Stores				
*May 7	Middletown Twp., N.J., Pal Shoe Store, et al.	..	2	300.0	..
	Shopping Centers				
May 6	New Hartford, N.Y., New Hartford Shopping Center, Inc.	..	4	320.5	7.0
Jul. 8	near Stockton, Calif., Gaines Market	..	1	280.0	..
Jul. 26	near Kansas City, Mo., Loma Vista Shopping Center	..	2	287.5	75.0
Aug. 22	Carpentersville, Ill., W. T. Grant & Co.	..	1	260.0	..
*Aug. 29	Neptune City, N.J., Kinney Shoe Store, et al.	..	2	588.0	..
Sep. 3	East Brunswick, N.J., J. J. Newberry & Co.	..	15	1,200.0	35.0
Dec. 6	Harwichport, Mass., Gr. Atlantic & Pacific Tea Co., et al.	..	..	250.0	nc
Dec. 31	Parma Heights, Ohio, Beck Shoe Store, et al.	..	..	270.0	9.5
	Supermarkets				
Jan. 31	Los Angeles, Calif., Von's Grocery Company	..	4	550.0	nc
Mar. 16	Long Branch, Ont., Dominion Stores	..	..	435.0	..
Mar. 20	San Jose, Calif., Lucky Markets	..	..	261.0	..
Apr. 21	East Gary, Ind., Five Star Supermarket	..	1	328.0	152.5
Jun. 9	Boise, Idaho, Albertson's Supermarket	..	2	448.5	Yes
Sep. 2	Springfield, N.J., Safeway Stores	..	2	450.0	..
Nov. 16	Santa Paula, Calif., Safeway Stores	..	..	405.0	nc
Nov. 25	Cambridge, Ohio, Kroger Supermarket	..	1	250.0	..
Dec. 9	Bellevue, Wash., P-X Supermarket	..	1	550.0	Yes
Dec. 26	Roselle, N.J., Roselle Shopping Center	..	..	284.0	..
Dec. 30	Wenatchee, Wash., John's E-Z Market	..	..	270.0	35.0
	Variety Stores				
Jan. 5	Sandusky, Ohio, F.W. Woolworth Co.	..	7	300.0	nc
Jul. 5	Monroe, Ga., Aycock's Department Store	..	2	250.0	..
Aug. 15	Red Bank, N.J., Prown's Dept. Store, et al.	..	2	250.0	..
Dec. 25	Kinston, N.C., Dupree's Children's Shop, et al.	..	3	250.0	..
	Other Mercantile				
Feb. 1	Huntington, L.I., N.Y., Huntington Office Building, et al (Furniture, books, clothing, office)	..	..	250.0	..
Apr. 9	Topeka, Kans., Lawrence Litwin, et al. (Clothing, rugs, dance studio, offices)	..	..	255.0	Yes

Table II — Continued

The Large Office Building Fires of 1960

	Total No. of Fires	Total No. Killed	Total No. Injured	Total Property Damage Loss In Thousands	Total Insured Indirect Loss In Thousands
U. S. Losses	2	0	0	$1,559.0	$0
Canadian Losses	0	0	0	0	0
Total Losses	2	0	0	$1,599.0	0

Date	Place and Occupant	No. Dead	No. Injured	Property Damage In Thousands	Insured Indirect Loss In Thousands
	Office Buildings, Government				
Oct. 3	Vicksburg, Miss., U. S. Army Engineers, et al	..	..	$1,349.0	nc
	Professional Offices				
Dec. 10	Patchogue, N.Y., Furman Building	..	..	250.0	nc

The Large Industrial Plant Fires of 1960

	Total No. of Fires	Total No. Killed	Total No. Injured	Total Property Damage Loss In Thousands	Total Insured Indirect Loss In Thousands
U. S. Losses	116	43	227	$70,523.0	$ 9,430.0
Canadian Losses	17	3	31	17,314.0	2,018.5
Total Losses	133	46	258	$87,837.0	$11,448.5

Date	Place and Occupant	No. Dead	No. Injured	Property Damage In Thousands	Insured Indirect Loss In Thousands
	Chemical, Chemical Products				
	Alcohol Plants				
Apr. 29	Newark, N.J., Kolker Chemical Corp.	..	..	$250.0	nc
	Asphalt Roofing Plants				
Mar. 3	Waukegan, Ill., Johns-Manville Corp.	..	..	1,750.0	1,000.0
	Essential Oils Manufacturing				
Nov. 17	East Hanover Twp., N.J., Norda Essential Oil & Chemical Co	..	6	325.0	..
	Explosives and Munitions Plants				
Feb. 9	near Havre De Grace, Md., Havre De Grace Fireworks Co., Inc.	1	5	485.0	..
*Jul. 27	Spanish Fork, Utah, American Cyanamid Co.	..	..	300.0	..
	Fertilizer Mixing Plants				
May 25	near Bunkie, La., Guaranty Seed Co.	..	..	435.0	..
	Gas Manufacturing				
†Apr. 20	Belle, W. Va., Union Carbide Corp.	..	..	750.0	..
	Refineries, Animal Oil				
Jul. 11	Cleveland, Ohio, Darling and Co.	..	..	300.0	..
Jul. 22	near Columbus, Ohio, Inland Products, Inc.	1	1	250.0	240.0
	Refineries, Petroleum				
Mar. 3	East Chicago, Ind., Sinclair Refining Co.	4	5	500.0	nc
†Aug. 21	Salt Lake City, Utah, Utah Oil Refining Co.	2	..	439.0	nc
†Sep. 9	Philadelphia, Pa., Gulf Oil Corporation	..	2	1,000.0	..
†Oct. 24	Freeport, Tex., Dow Chemical Co.	6	13	325.0	500.0

Table II — Continued

Industrial Plants (Cont.)

Date	Place and Occupant	No. Dead	No. Injured	Property Damage In Thousands	Insured Indirect Loss
Refineries, Vegetable Oil					
Apr. 30	near Sidney, Nebr., Pacific Vegetable Oil Corp.	..	..	500.0	5.0
Rocket Fuel Manufacturers					
Jan. 8	near Marshall, Tex., Longhorn Ordnance Plant	..	..	250.0	nc
Other Chemical Plants					
Apr. 25	near Memphis, Tenn., E. I. du Pont de Nemours & Co., Inc. (Hydrogen peroxide)	..	..	500.0	..
Jun. 2	Deepwater, N.J., E. I. du Pont de Nemours & Co. Chambers Works (Dinitrotoluene)	..	1	600.0	..
Aug. 30	Buffalo, N.Y., National Aniline — Div. of Allied Chemical and Dye Corp. (Dyes, other organic chemicals)	1	2	800.0	400.0
Sep. 11	Brunswick, Ga., Allied Chemical Corp., Solvay Process Div. (Sodium carbonate)	..	..	375.0	40.0
*Oct. 4	Kingsport, Tenn., Tennessee Eastman Co. (Aniline)	15	60	4,500.0	..
	Food, Food Products				
Bakeries					
Mar. 1	Edmonton, Alta., Canadian Bakeries, Ltd.	..	..	331.5	nc
Canneries					
Mar. 3	Port Graham, Alaska, Fidalgo Island Packing Co.	..	..	600.0	nc
*Nov. 12	New Sharon, Maine, Medomak Canning Co.	..	..	1,000.0	..
Flour Mills					
Mar. 4	Estherville, Iowa, Supersweet Feeds, Div. of International Milling Co.	..	..	447.5	..
Jul. 19	Joliette, P.Q., LeMeunerie Co-operative de Joliette, P.Q.	..	..	291.5	nc
*Oct. 7	Port Colborne, Ont., Maple Leaf Milling Co. Ltd.	1	6	7,513.5	Yes
*Oct. 13	Millington, Mich., Frutchey Bean Co.	..	..	250.0	..
Fruit and Vegetable Packing					
*Feb. 9	Palmetto, Fla., Harllee Farms Packing House	..	2	575.0	..
*Nov. 22	near Lakeland, Fla., Lakeland Packing Co., Inc.	..	..	625.0	..
Macaroni Plants					
Oct. 25	Lebanon, Pa., San Giorgio Macaroni, Inc.	..	4	1,000.0	Yes
Meat Packing, Processing					
Feb. 12	Fostoria, Ohio, Wood County Packing Co.	..	1	445.5	nc
Nov. 20	near Butte, Mont., Sigman Meat Co.	..	..	300.0	200.0
Potato Chip Plants					
Sep. 16	Fall River, Mass., Made Rite Potato Chip Co., Inc.	..	..	280.5	..
Poultry Farms					
May 4	Zeeland, Mich., Dewitts Zeeland Hatchery	..	..	300.0	nc
Oct. 30	Hemlock, Mich., Hess Duck Farm	..	..	275.0	..
Rice Mills					
Apr. 7	Altair, Tex., Altair Rice Dryer, Inc.	..	..	350.0	..
Other Food Milling					
Jan. 17	La Prairie, P.Q., Fred A. Lallemand & Cie. (Yeast, yeast products)	..	..	304.0	nc
	Glass, Glass Products				
Glass Products Plants					
*Apr. 2	New York, N.Y., Aquarium Stock Co., Inc. (Fish tanks)	..	11	304.0	..
Apr. 6	No. Agua, N.Mex., Johns-Manville Perlite Corp.	..	..	380.0	400.0
Apr. 12	Dunkirk, Ind., Indiana Glass Co. (Glassware)	..	..	400.0	nc
	Leather, Leather Products				
Shoe Manufacturing					
Apr. 24	Wilkes-Barre, Pa., Royal Footwear Co., et al	..	3	650.0	40.0
May 6	Derry, N.H., Chelmsford Shoe Co., Inc., et al	..	15	972.0	45.0

Table II — Continued

Industrial Plants (Cont.)

Date	Place and Occupant	No. Dead	No. Injured	Property Damage In Thousands	Insured Indirect Loss
	Metal, Metal Products				
	Aluminum Fabricating				
Mar. 12	Calgary Alta., Alsco Ltd. of Canada	..	..	275.0	..
	Copper, Tin, Zinc Fabricating				
Feb. 11	Waterloo, Ind., T. H. Products Corp.	..	..	342.0	nc
	Electrical Appliances, Assembling				
May 3	Chicago, Ill., Electro Lighting Corp.	..	..	966.0	387.5
Jun. 22	Fort Smith, Ark., Landers of Arkansas, Inc.	..	10	1,230.0	500.0
Jul. 7	Schenectady, N.Y., General Electric Co.	..	..	496.0	nc
Oct. 8	near Fowler, Ind., General Transformer Co.	..	..	464.0	Yes
	Iron Casting				
Mar. 9	Bowmanville, Ont., Bowmanville Foundry Co.	..	..	383.5	..
Jun. 5	Burnaby, B.C., Coast Foundry Co., Ltd.	..	..	280.5	..
Jun. 21	Anniston, Ala., Rudsill Pipe & Foundry Co.	..	2	250.0	..
	Iron Fabricating				
Oct. 9	Hamilton, Ont., Continue Flo Heating Products, Ltd.	..	2	322.0	..
	Metal Machining				
Feb. 28	Kansas City, Mo., Brunson Instrument Co.	..	2	519.0	307.5
	Steel Fabricating				
*Jan. 4	Bedford Park, Ill., Bethlehem Steel Corp.	..	..	1,040.0	nc
Jan. 5	Roseville, Mich., Detroit Unit Exchange Co., Inc.	..	..	260.0	..
Mar.	near Salina, Kansas, Grain Belt Supply Company	..	..	297.0	..
Mar. 29	Cincinnati, Ohio, U. S. Drill Head Co.	..	1	252.0	..
*Apr. 19	Morris, Ill., Northwestern Corp.	..	..	276.0	..
Apr. 28	Shady Grove, Pa., Grove Manufacturing Co.	..	..	250.0	..
Jun. 4	Los Angeles, Calif., Nelson's Refrigeration & Fixtures, Inc.	..	..	250.0	40.0
Jul. 18	Onalaska, Wisc., Outers Laboratories, Inc.	..	..	377.5	50.0
Aug. 15	Houston, Tex., Rheem Manufacturing Co.	4	8	750.0	400.0
Sep. 14	Clayton, N.Y., Frink Sno-Plows, Inc.	..	..	500.0	..
Nov. 3	Vincennes, Ind., Vincennes Steel Corp.	..	1	425.0	200.0
Dec. 12	Philadelphia, Pa., Crown Cork & Seal, Inc.	..	..	675.0	..
	Vehicle Assembly				
Apr. 2	Los Angeles, Calif., McDermott-Greene, Inc., et al	..	..	265.5	25.0
Aug. 13	Rapid City, S. Dak., New Moon Homes, Inc.	..	1	700.0	nc
Oct. 22	Masury, Ohio, General American Transportation Corp.	..	..	3,000.0	..
	Other Metals, Refining and Smelting				
Jan. 31	nr Albany, Oreg., Oregon Metallurgical Corp. (Vanadium)	2	..	384.5	48.0
	Mineral, Mineral Products				
	Brick and Tile Plants				
Oct. 13	Tilton, Ill., General Refractories Co.	..	1	260.0	nc
	Cement Plants				
Aug. 11	near Blue Rapids, Kans., Bestwall Gypsum Co.	..	..	250.0	200.0
	Paper, Paper Products				
	Paper Mills				
Dec. 31	near Macon, Ga., Mead Corp.	..	5	350.0	400.0
	Paper Products Fabricating				
Feb. 5	Cleveland, Ohio, Sobel Corrugated Containers, Inc.	..	1	269.0	37.5
*Mar. 9	East St. John, N.B., Maritime Cartons, Ltd., et al	..	4	425.0	268.5
Mar. 15	North York Twp., Ont., Weber Costello Co.	..	1	255.0	..
Mar. 16	Detroit, Mich., Cleveland Container Co.	..	..	453.5	..
Jul. 31	Los Angeles, Calif., Hoffmaster Pacific Co.	..	1	425.0	nc
Oct. 5	Vandalia, N.C., American Paper Products Co.	..	3	250.0	..

Table II — Continued

Industrial Plants (Cont.)

Date	Place and Occupant	No. Dead	No. Injured	Property Damage In Thousands	Insured Indirect Loss
	Plastics, Plastic Products				
	Molded Plastic Products Fabricating				
Oct. 22	Lockport, N.Y., Sterling Moulders, Inc.	..	..	535.0	100.0
	Plastic Films and Sheets Fabricating				
Jul. 29	Princeton, Minn., Fingerhut Mfg. Co.	..	1	835.0	nc
	Plastic Manufacturing				
Sep. 29	Bay City, Mich., Dow Chemical Co.	1	5	450.0	1,500.0
Oct. 17	Montreal, P.Q., Union Carbide Canada, Ltd.	..	..	500.0	Yes
*Nov. 8	Wilmington, Del., Synvar Corporation	5	4	270.0	60.0
	Other Plastic Product Fabricating (Artificial Flowers)				
Dec. 20	Minneapolis, Minn., Northern States Floral Co.	..	..	495.0	75.0
	Photography, Printing				
	Photographic Reproduction				
*Mar. 1	Bridgeville, Pa., Sablo's Photo Studio, et al	..	5	500.0	..
Apr. 9	Los Angeles, Calif., Tri-Color Laboratories	..	..	339.0	300.0
	Printing, Typesetting				
Apr. 18	Kahoka, Mo., Moore Business Forms	..	..	1,000.0	1,000.0
Dec. 2	Syracuse, N.Y., Acme Printing Co., et al	..	..	450.0	..
Dec. 8	Chicopee Falls, Mass., Rich Lithographing Co.	..	3	1,082.0	..
Dec. 26	Chicago, Ill., Litho Tone, Inc., et al	..	3	250.0	..
	Rubber, Rubber Products				
	Tire Recapping, Repair				
*Dec. 10	Peoria, Ill., Reliable Tire Company	..	..	430.0	35.0
	Textiles, Textile Products				
	Cloth Coating				
*Feb. 17	Clifton, N.J., Velveray Corp., et al	..	10	8,000.0	very high
	Clothing Plants				
Mar. 20	Brooklyn, N.Y., Ripley Mfg. Co. and Bridgeport Realty Co.	..	4	374.5	39.0
Jun. 25	Bridgeport, Conn., Nicholas Paneteri Co., et al	..	3	250.0	23.5
Nov. 9	Jersey City, N.J., Wonderland Fashions, Inc., et al	..	2	300.0	..
	Hat Manufacturing				
Sep. 26	Beacon, N.Y., Dorrell Hat Co.	..	..	330.0	..
	Synthetic Fibers, Part Process Mills				
Feb. 6	Paterson, N.J., Freetex Weaving Corp., et al	..	2	300.0	Yes
	Upholstering Plants				
Dec. 1	Guntown, Miss., Comfort Furniture Mfg. Co.	..	..	340.0	nc
	Wood, Wood Products				
	Box Plants				
Aug. 19	Suamico, Wisc., Suamico Box Co.	..	..	269.5	260.5
	Charcoal Mfg. and Processing				
Jul. 20	Kenbridge, Va., Imperial Briquet Corp.	..	..	407.0	26.5
	Furniture Plants				
Feb. 13	Houston, Tex., W. M. Gidding Furniture Mfg. Co.	1	..	282.5	..
Jun. 4	Greenville, Tenn., Sam Moore, Inc.	..	..	285.0	Yes
Jul. 20	Pontiac, Ill., Pontiac Chair Co., Inc.	..	..	268.0	nc
Dec. 28	Farnham, P.Q., Gelco Furniture Co., Ltd.	..	..	1,000.0	250.0

Table II — Continued

Industrial Plants (Cont.)

Date	Place and Occupant	No. Dead	No. Injured	Property Damage In Thousands	Insured Indirect Loss
Hardwood Turning Plants					
Oct. 22	Lowville, N.Y., American Machine & Foundry Co.	..	..	300.0	300.0
Plywood Manufacture					
*May 19	Pineville, La., Red River Veneer Co., Inc.	..	1	250.0	..
Saw, Planing Mills					
*Apr. 13	Epworth, S.C., Piedmont Pine Corp.	..	..	300.0	..
May 26	Whittier, Alaska, Columbia Lumber Co.	..	1	750.0	nc
May 26	near Spindale, N.C., Koon Builders Supply Co.	..	1	250.0	nc
*Jun. 4	Mansfield, La., Matthews Lumber Co.	..	..	292.0	..
*Jun. 5	near Remote, Oreg., Cawrse Lumber Co.	..	..	257.5	..
Jun. 26	near Glendale, Oreg., Patterson Lumber Co.	..	..	258.0	..
*Jul. 3	Vancouver, B.C., British Columbia Forest Products Ltd.	..	10	2,981.0	600.0
Aug. 30	Mist, Oreg., Mist Lumber Co.	..	..	299.0	56.0
Dec. 9	Fitzgerald, Ga., Roundtree-Hunter Lumber Co.	..	..	340.0	..
Wood Boat Manufacturing					
Apr. 23	Grand Rapids, Mich., Wagemaker Boat Corp.—Moulded Shapes Division	..	2	279.5	..
Wood Building Products Manufacturing					
Dec. 7	Scarborough, Ont., Premium Forest Products	..	..	465.5	..
Wood Fiber Products Plants					
*Feb. 13	Alexandria, La., Afco Corporation	..	..	286.5	nc
Feb. 20	Gatineau, P.Q., International Fibreboard Ltd.	2	1	1,200.0	900.0
Wood Toy Manufacturing					
Jun. 16	N. Versailles Twp., Pa., Cravotta Bros.	..	..	300.0	..
Other Woodworkers					
Jul. 12	Brookville, Ohio, Vindale Corp. (Trailer coaches)	..	4	275.0	150.0
	Miscellaneous Industries				
Electric Generating Plants, Substations					
Feb. 7	Ridgefield, N.J., Public Service Electric and Gas Co.	..	1	3,155.0	nc
*Sep. 10	Baie Verte, N.F., Thistle & Sons, Ltd.	..	..	500.0	..
†Sep. 12	Lower Mount Bethel Twp., Pa., Pennsylvania Power & Light Co.	..	..	1,110.0	..
Garages, Repair with Sales					
*Jun. 9	Danville, Ky., Danville Motor Co., et al	..	3	250.0	..
Laboratories, General					
Dec. 7	Robins AFB, Ga., United States Government Repair Shop	..	2	1,116.0	..
Laundries					
Jul. 31	Portland, Oreg., New System Laundry	..	..	437.5	39.0
Dec. 7	New Westminster, B.C., Royal City Laundry	..	7	286.0	..
*Dec. 12	Lawrence, Mass., Standard Coat, Apron & Towel Supply Co.	..	3	500.0	..
Motion Picture Studios					
Jun. 5	Los Angeles, Calif., Republic Studios	..	..	250.0	nc
Railroad Repair Shops					
*Jan. 24	near Wichita, Kans., Missouri Pacific Railroad Repair Shop	..	..	409.0	nc
Jan. 28	Oelwein, Iowa, Chicago Great Western Railroad Co.	..	..	500.0	nc
Ship Fabricating Plants					
Nov. 29	Tampa, Fla., Tampa Ship Repair & Dry Dock Co.	..	..	300.0	..

Table II — Continued

The Large Storage Building Fires of 1960

	Total No. of Fires	Total No. Killed	Total No. Injured	Total Property Damage Loss In Thousands	Total Insured Indirect Loss In Thousands
U. S. Losses	44	9	75	$23,291.5	$143.0
Canadian Losses	7	0	1	2,055.0	275.0
Total Losses	51	9	76	$25,346.5	$418.0

Date	Place and Occupant	No. Dead	No. Injured	Property Damage In Thousands	Insured Indirect Loss
	Autos, Farm and Road Machinery Storage				
Mar. 25	near Winnipeg, Man., Forsythe Construction Co., Ltd.	..	1	$260.0	..
Apr. 7	near Camden, Ark., Berg Warehouse	..	..	250.0	nc
Aug. 20	Winnipeg, Man., Allis-Chalmers Rumely Ltd.	..	..	325.0	..
	Barns				
*Jan. 6	near Emporia, Kans., Bluestem Feed Yards, Inc.	..	..	400.0	..
	Chemical and Drug Storage				
May 10	near Boron, Calif., Pacific Coast Borax Co.	..	..	250.0	nc
	Cold Storage				
Jul. 8	Verona, N.J., Can-Meat Corp., et al	..	..	250.0	..
Nov. 10	near Nogales, Ariz., Sinaloa Valley Cold Storage, Inc.	..	..	1,133.0	..
Dec. 24	Parsonsfield, Maine, Lord Apple Packing Plant	..	1	275.0	..
	Cotton Storage				
Mar. 4	Henrietta, N.C., Burlington Industries, Inc.	..	..	300.0	nc
	Electrical Appliance, Supply Storage				
Jun. 16	near Middletown, Pa., A.I.L. Company, et al	..	..	551.5	Yes
Oct. 4	Oakland, Calif., Westinghouse Electric Corp.	..	1	602.0	nc
	Food Product Storage				
*Feb. 23	Caro, Mich., W. N. Clarke Co.	..	..	400.0	..
Mar. 3	near Nashville, Tenn., Bi-Rite Food Stores, Inc., et al.	..	..	946.0	nc
Mar. 18	Indio, Calif., Valley Date Gardens, Inc.	..	..	290.0	nc
Apr. 12	Henrietta, N.Y., Genesee Valley Regional Market	..	2	500.0	..
Dec. 30	Maryville, Mo., Townsend Wholesale Grocery Co.	..	..	250.0	..
	Furniture Storage				
	General Furniture Storage				
Jan. 25	Buffalo, N.Y., A. J. Spangenthal Furniture Co.	..	3	310.0	..
Mar. 12	Brooklyn, N.Y., General Furniture Co.	..	6	339.0	..
	Public Household Furniture Storage				
Sep. 19	Sierra Vista, Ariz., H & R Transfer Co.	..	..	295.0	nc
	Grain Elevators				
	Country Grain Elevator				
*Nov. 30	Sexsmith, Alta., Alberta Wheat Pool	..	..	344.0	..
	Terminal Grain Elevators				
Jul. 19	Brownfield, Tex., Goodpasture Grain & Milling Co., Inc.	6	2	266.5	nc
Aug. 23	Denver, Colo., Colorado Milling & Elevator Co.	..	4	494.0	nc
Sep. 1	Letellier, Man., Manitoba Pool Elevator	..	..	275.0	..
Nov. 6	Missouri Valley, Iowa, Loveland Elevator Co.	..	..	500.0	nc
	Grain, Feed, Seed, Hay Storage				
Feb. 2	Ailsa Craig, Ont., Alex M. Stewart & Son	..	..	265.0	..
Sep. 20	near Bloomington, Ill., Funk Brothers Seed Co.	..	..	250.0	100.0
Nov. 4	Monroe, Iowa, Pfister Hybrid Processing Plant	..	..	282.0	nc

Table II — Continued

Storage Building Fires (Cont.)

Date	Place and Occupant	No. Dead	No. Injured	Property Damage In Thousands	Insured Indirect Loss
	Hardware Storage				
Mar. 26	Brooklyn, N.Y., Transportation Parts Co., et al	..	5	250.0	30.0
Aug. 31	Millville, N.J., Lund Aviation Corp.	..	2	500.0	..
	Liquor Storage				
Jun. 30	near Owensboro, Ky., Medley Distilling Co.	..	1	996.5	..
	Lumberyard				
Mar. 9	New York, N.Y., Abrem Cohen Lumberyard	..	2	750.0	..
*Mar. 13	Louisville, Ky., Kentucky Lumber Co.	..	2	555.0	..
	Machinery Storage				
Jul. 19	Lima, Ohio, Palmer-Donavin Mfg. Co.	..	1	398.0	nc
Sep. 13	St. John, N.B., Canadian Fairbanks-Morse Co., Ltd.	..	..	286.0	275.0
	Metal, Metal Products Storage				
Apr. 14	Leetsdale, Pa., Standard Can Corp., et al	..	..	433.0	..
Apr. 19	Tampa, Fla., D. H. Overmyer Warehouse Co.	..	3	357.0	..
Nov. 5	Sacramento, Calif., McClennan Air Force Base	..	5	1,425.0	nc
	Outdoor Storage				
†Jun. 9	near Seaford, Del., E. I. du Pont de Nemours & Company — Nylon Plant	..	1	500.0	nc
†Aug. 18	Toronto, Ont., Levy Auto Parts Ltd.	..	..	300.0	..
	Paper, Paper Products Storage				
*Jul. 11	Worcester, Mass., Charles Dowd Box Co., Inc.	..	3	500.0	Yes
	Petroleum, Petroleum Products Storage				
	Airport Petroleum Distributing Station				
*Sep. 21	Houston, Tex., Trans-Texas Airways	..	1	392.0	nc
	Petroleum Bulk Plant				
Apr. 14	Pine Bluff, Ark., H. S. Lee Bulk Oil Plant, et al	..	1	287.0	nc
	Piers and Wharves				
†Mar. 17	Los Angeles, Calif., Los Angeles Harbor Dept. Wharf	..	6	1,000.0	nc
Jul. 10	Portland, Oreg., Globe Dock & Elevator Co.	..	..	911.0	nc
	Plastic and Plastic Products Storage				
Oct. 12	Golden Valley, Minn., Margo-Kraft Distributors	..	1	790.0	Yes
	Stables				
Aug. 8	Ho-Ho-Kus, N.J., Chestnut Ridge Riding Club	..	2	250.0	..
	Terminal Warehouse				
Apr. 28	Phoenix, Ariz., Schade Transfer Co., et al	..	1	320.5	..
	Textile Storage				
*Nov. 18	New York, N.Y., Capitol Textile Bldg., et al	3	18	1,000.0	..
Dec. 28	Newark, N.J., Stephen-Leedom Carpet Co.	..	..	1,200.0	nc
	Tobacco Storage				
Dec. 20	Columbus, Ohio, Sharwell Tobacco Co.	..	..	700.0	nc
	Wood, Wood Products Storage				
*Mar. 27	Rockford, Ill., Rockford Chair & Furniture Co.	..	1	642.5	13.0

Table II — Continued

The Large Transportation Vehicle Fires of 1960

	Total No. of Fires	Total No. Killed	Total No. Injured	Total Property Damage Loss In Thousands	Total Insured Indirect Loss In Thousands
U. S. Losses	38	130	381	$139,559.5	$0
Canadian Losses	1	0	0	750.0	0
Total Losses	39	130	381	$140,309.5	$0

Aircraft (See Key to Abbreviations, next page)

Date	Place	Type Accident	Operator	Type Aircraft	Estimated Loss	Number Aboard	Killed On Ground
Jan. 14	Eielson AFB, Alaska	CF	USAF	B-47	$1,883,000	2	0
Feb. 1	Ramey AFB, Puerto Rico	CF	USAF	B-52G	11,000,000	7	0
Feb. 3	Walker AFB, New Mexico	CF	USAF	3 KC-135's	21,400,000	5	4
Feb. 7	Los Angeles, Calif.	CF	PAA	707-321	300,000	0	0
Feb. 11	Puget Sound, Washington	FF	USN	P5M	1,500,000	9	0
Mar. 6	Vandenberg AFB, Calif.	GF	USAF	Atlas Missile	over 1,000,000	0	0
Mar. 8	Carswell AFB, Texas	CF	USAF	KC-135	over 3,000,000	0	0
Mar. 27	Fort Sill, Okla.	CF	USA	H-37	750,000	5	0
Mar. 28	U. S. Naval Air Station, North Island, San Diego, Calif.	FF	USN	AD-6	250,000	1	0
Mar. 31	Little Rock, Ark.	CF	USAF	B-47	250,000	3	2
Apr. 1	Fairchild AFB, Washington	GF	USAF	B-52	5,000,000	0	0
Apr. 15	Lincoln AFB, Nebraska	CF	USAF	KC-97G	1,205,000	0	0
Apr. 15	Off California Coast	FF	USN	Skyraider	750,000	2	0
Apr. 23	Sikorsky Heliport, Stratford, Conn.	CF	USN	HSS-2 (S-61)	750,000	3	0
May 9	New York International Airport, New York, N. Y.	CF	TWA	707-331	500,000	0	0
May 23	Atlanta Municipal Airport, Atlanta, Georgia	CF	Delta	880	5,000,000	4	0
June 7	Patuxent NAS, Maryland	CF	USN & USAF	F8U and Helicopter	1,500,000	0	4
June 7	McGuire Air Force Base, N. J.	GF	USAF	Bomarc Missile	over 1,000,000	0	0
June 8	Edwards AFB, Calif.	GF	USAF	X-15	over 1,000,000	0	0
June 27	near Bethel, Maine	FF	USAF	KC-97G	1,200,000	5	0
July 12	near Clewiston, Florida	FF	USAF	B-47B	2,500,000	0	0
July 14	near Bracketville, Texas	FF	USAF	U-2	over 1,000,000	0	0
July 19	Daufuskie Island, S. C.	FF	USN	HSS-1N Helicopter	750,000	3	0
Aug. 12	Plattsburg AFB, New York	CF	USAF	B-47E	778,000	0	0
Sept. 11	Andrews AFB, Md.	GF	USAF	F-86H	582,500	0	0
Sept. 14	LaGuardia Airport, New York	CF	AA	Electra	2,300,000	0	0
Sept. 14	Love Field, Dallas, Texas	GF	Braniff	DC-1C	712,000	1	0
Oct. 18	near Langley AFB, Va.	CF	USAF	KB50-J	1,000,000	7	0
Nov. 8	Lockbourne AFB, Ohio	CF	USAF	B-47E	2,500,000	5	0
Nov. 18	Loring AFB, Maine	CF	USAF	KC-135	3,500,000	1	0
Dec. 3	Vandenberg AFB, Calif.	GF	USAF	Titan Missile	5,000,000	0	0
Dec. 15	Larsen AFB, Washington	CF	USAF	B-52D	8,007,000	0	0
Dec. 16	Brooklyn and Staten Island, N. Y.	CF	UAL & TWA	DC-8 and Constellation	1,000,000	0	6
					$88,867,500	63	16

Table II — Continued

Transportation Vehicle Fires (Cont.)

Date	Place and Occupant	No. Dead	No. Injured	Property Damage In Thousands	Insured Indirect Loss
	Railroad Rolling Stock				
Aug. 28	near Ottawa, Kans., Atchison, Topeka & Santa Fe	..	..	$1,000.0	nc
Dec. 17	near Traskwood, Ark., Missouri Pacific Railroad	..	5	500.0	nc
	Ships				
	Passenger and Cargo Ships				
Aug. 19	Lake St. Peter, P.Q., Bell Isle II	..	..	750.0	nc
	Warships			less than	
Jun. 14	Pearl Harbor, Hawaii, U.S.S. Sargo	1	..	1,000.0	nc
Dec. 19	Brooklyn, N.Y., U.S.S. Constellation	50	376	47,942.0	nc
	Trucks				
May 5	near Carrollton, Ky., Western Pipe Line Co.	..	..	250.0	nc

Key to Abbreviations

Type Accident
CF — Crash Fire
FF — Fire in Flight
GF — Ground Fire

Military Operators
USA — United States Army
USAF — United States Air Force
USN — United States Navy

Civil Operators
AA — American Airlines
PAA — Pan American Airways
TWA — Trans World Airways
UAL — United Air Lines

NOTE: Aircraft type designations for military aircraft are the official designations used by the United States Military Services. The following are further identifications of the aircraft on this year's list.

USA Aircraft Designations
H-37 — Sikorsky S-56

USAF Aircraft Designations
B — Bomber
F — Fighter
KB — Tanker (Air-borne Refueling)
KC — Tanker (Air-borne Refueling)
U — Research
X — Experimental

USN Aircraft Designations
AD-6 — Douglas Skyraider
F8U — Chance Vought Crusadet
HSS-1 — Sikorsky S-58 Helicopter
HSS-2 — Sikorsky S-61 Helicopter
P5M — Martin Marlin

The Other Large Fires of 1960 (Excluding Transportation)

	Total No. of Fires	Total No. Killed	Total No. Injured	Total Property Damage Loss	Total Cost of Suppression (Forest Fires Only)
U. S. Losses	25	5	49	$39,967.0	$9,877.0
Canadian Losses	5	0	1	3,558.5	309.0
Total Losses	30	5	50	$43,525.5	$10,186.0

Date	Place and Occupant	No. Dead	No. Injured	Property Damage In Thousands	Insured Indirect Loss
	Buildings Being Demolished				
Aug. 29	New Haven, Conn., Vacant Loft Bldg.	..	13	600.0	nc
	Buildings Under Construction				
Jan. 30	Kelsey, Man., Manitoba Hydro Board	..	..	$1,000.0	nc
*Oct. 27	Calgary, Alta., Concord Investments Ltd.	..	1	325.0	nc

Table II — Concluded

Other Large Fires (Cont.)

Date	Place and Occupant	No. Dead	No. Injured	Property Damage In Thousands	Cost of Suppression In Thousands
	Forest Fires				
May 29	Lake Jeannine, P.Q., The Jeannine Fire Carelessness (traveler) — 37,440 acres	..	..	920.0	$136.0**
Jun. 19	San Bernardino National Forest, Calif., The Armstrong Fire Incendiary — 495 acres	..	..	524.0	125.0**
Jun. 25	Angeles National Forest, Calif., The Reese Fire Incendiary — 1,648 acres	..	..	449.0	130.0**
Jun. 28	Cleveland National Forest, Calif., The Bedford Fire Unreported — 465 acres	..	..	318.0	26.0**
Jul. 9	Sequoia National Forest, Calif., The Coffee Camp Fire Incendiary — 1,105 acres	..	..	355.5	106.5**
Jul. 13	Twp. 15N, Section 9, Mont., The Gold Creek Fire Lightning — 3,080 acres	..	14	801.0	213.0**
Jul. 17	Angeles National Forest, Calif., The Polecat Fire Smoking — 14,737 acres	..	..	10,977.0	750.0**
Jul. 19	Angeles National Forest, Calif., The Magic Fire Lightning — 25,073 acres	3	..	1,057.5	525.0**
Jul. 19	Twp. 6S, Section 30, Oreg., The Anthony Creek Fire Lightning — 19,000 acres	1	..	2,214.0	1,478.5**
Jul. 20	Angeles National Forest, Calif., The Johnstone Fire Lightning — 19,819 acres	..	..	11,033.5	800.0**
Jul. 20	Cleveland National Forest, Calif., The Pleasant Fire Unreported — 2,059 acres	..	..	1,157.5	195.0**
Jul. 20	Hells Canyon on the Snake River, Idaho, The Echols Fire Lightning — 14,500 acres	..	..	250.0	350.0**
Jul. 20	Idaho City, Idaho, The Thorn Creek Fire Undetermined — 7,140 acres	..	..	875.0	250.0**
Jul. 20	Twp. 7N, Section 22, Wash., The Wenatchee Creek Fire Lightning — 8,140 acres	..	..	407.0	213.0**
Jul. 24	Stanislaus National Forest, Calif., The Flora Fire Smoking — 2,040 acres	..	..	692.0	300.0**
Aug. 2	San Bernardino National Forest, Calif., The Sayles Fire Smoking — 5,520 acres	..	..	1,198.5	225.0**
Aug. 11	near Pavilion, B.C. Unreported — Railroad engine fell through trestle weakened by forest fire.	..	..	266.0	..
Aug. 13	Plumas National Forest, Calif., The Mosquito Fire Lightning — 4,020 acres	..	..	262.5	525.0**
Aug. 16	Pabos Twp., P.Q., The Pabos Fire Carelessness (forest workers) — 39,220 acres	..	..	1,047.5	173.0**
Aug. 20	Tahoe National Forest, Calif., The Donner Ridge Fire Clearing of Right of Way — 48,777 acres	1	..	2,615.0	1,785.0**
Aug. 20	Tahoe National Forest, Calif., The Volcano Fire Smoking — 44,386 acres	..	..	1,622.0	1,700.0**
Aug. 22	near Hot Springs, S.Dak., The Green Canyon Fire Lightning — 6,300 acres	..	3	560.0	95.0**
Aug. 22	Hot Springs SW-8, S.Dak., The Wildcat Fire Lightning — 9,973 acres	..	6	346.0	85.0**
Oct. 18	near Napa, Calif., The Soda Canyon Fire Carelessness (resident burning trash) 4,000 acres	..	..	802.0	..
	Idle, Vacant Buildings				
*Feb. 12	Kansas City, Mo., Henry & Lenore Fishman, et al	..	6	350.0	..
*Apr. 15	Newark, N.J., Household Fuel Trestle, Inc.	..	6	250.0	..
*Jun. 11	Columbia, Tenn., Louisville & Nashville Railway	..	1	250.0	..

** Cost of suppression

Rocket Experiment Safety

By Atlantic Research Corp., Alexandria, Virginia

This article was written by two members of the staff of the Atlantic Research Corp., in answer to requests for safety suggestions for rocket hobbyists in and around Alexandria.

The intent of this article is to discourage unsupervised amateur rocketry which has been the cause of much loss of life and serious injury. It shows the extent of the hazards involved and gives safety guidance to those who have genuine scientific interest in rocketry.

Other NFPA material on rocketry includes "Supervision of Teen-Age Rocketeers" by Carroll E. Shaw (October 1958 QUARTERLY) and "Amateur Rocketry — This Is Science?" (May 1958 *Fire News*).

It is impossible to give complete safety instructions for such a complex activity as rocket making and testing. Even were it possible, the most elaborately detailed instructions would be useless if the rocket experimenter did not read them attentively and then keep safety — his own and the community's — uppermost in his mind.

This article does not pretend to be an authoritative guide to every phase of amateur rocket work. Whole books have been written on the subject. We urge that no one regard the instructions contained in this article as a guarantee of safety in rocket work. It only attempts to outline the areas of greatest hazard and to give a few suggestions to minimize the danger. Its purpose is to fill an immediate need and its brevity has been dictated by the urgency of that need.

The public's reaction to the rocket hobby has ranged from qualified approval to demands that all such activity be banned. The authors, as individuals, believe the interest in this hobby is so intense that an official ban will merely drive the activity underground, making the situation worse than it is now. They further believe that the rocket hobby can yield positive good in science education if it is conducted with the guidance of adult sponsors who appreciate the need for proper precaution.

It is hoped that a careful reading of this article and the references listed in it, joined with serious acceptance of safety responsibility by competent adult sponsors and the individual hobbyist, will make amateur rocketry at least as safe as some other popular hobbies. It should be remembered that serious injuries do occur, although infrequently, even in such seemingly harmless activities as competitive sports.

Safety Is Where You Begin

Rocket experimentation is a fascinating hobby and offers many opportunities to learn the laws of nature that will make it possible for man to travel through space. Engineers and scientists have been working such a short time in the development of rocket propulsion techniques that much is yet to be learned about the principles and designs that will make our rockets of the future more efficient than those we have today.

High school and college students who take up this hobby in the right way will be making a good start toward a later career in rocketry or other technical fields.

A rocket accident is not a good start toward anything. It hurts — or kills. It costs your hand, your eyes, or your life. It completely wastes your knowledge and abilities, grieves your family, and frightens others away from an activity that can be made reasonably safe by foresight, knowledge, and caution.

Your first step in rocket experimentation must be to understand just why safety is so important in rocket work. There are three basic reasons:

First, a rocket propellant is a chemical mixture that is only a hairline removed from an explosive compound. Heating it, grinding it, or sometimes merely shaking it can detonate it like TNT. Many deaths and serious accidents have occurred when propellants detonated while being mixed on the workbench.

Second, a rocket propellant within a rocket case is literally a bomb unless both are properly designed. Even a safe propellant in a badly designed rocket case will explode the rocket, scattering shrapnel like a bursting artillery shell.

Third, the rocket itself is a projectile. It can move at such speed that it can readily kill. A good deal of aerodynamic knowledge is needed to design and make a rocket that will fly where it is supposed to fly.

"Well," you may be saying now, "I only planned to build a very *small* rocket." Good! But what do you mean, "small"? A 12-gauge high-velocity shotgun shell contains less than half an ounce of powder (a propellant), and it can kill. The hazard involved in handling propellant increases very rapidly as the amount increases:

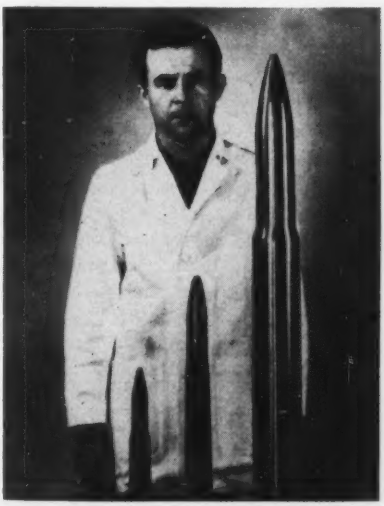
2 ounces of propellant is *8 times* as dangerous as *1* ounce.

5 ounces of propellant is *125 times* as dangerous as *1* ounce.

10 ounces of propellant is *1,000 times* as dangerous as *1* ounce.

Look at Figure 1, to get an idea of the energy present in various amounts of propellant. It takes only 4 pounds of propellant to hurl a 3-inch shell over 5 miles.

This article is meant to help you keep safe while learning how to experiment with rockets. It also suggests a number of interesting ways in which you can demonstrate to yourself the basic principles of rocket science. Serious experimentation of this kind is a worthwhile hobby if carried out safely. But no matter how serious and worthwhile your aim, experimentation without care and caution is senseless and dangerous playing with fire.



30 MM ½ lb. 40 MM ¾ lb. 3-in. 4 lb.

Figure 1. The gunpowder in these large caliber gun shells contains about the same explosive energy per pound as the energy in a rocket propellant. The type and weight of propellant are indicated under each shell.

Making Your Own Rocket

The Fuel

When you became interested in the rocket hobby, probably the first thing you thought of doing was making your own propellant. Unfortunately, propellant formulation, which seems so simple, is actually the most uncertain and dangerous part of the entire rocket field. Even the experts cannot predict whether an experimental propellant will actually turn out to be a high explosive.

Experienced propellant chemists conduct their initial tests of a new propellant mixture with tiny quantities of less than a gram. They use remote control equipment whenever they can. If they must handle their materials directly, they protect their eyes with safety glasses. They test their samples against heat and shock, not only when the sample is freshly made, but also after storage for days, weeks, and months. They have found that many things can make the difference between a propellant and an explosive. The chemicals used, their proportions, the particle size of the powders, even the minute impurities present in the ingredients can make the difference.

Some substances are so sensitive or so toxic that professional rocket makers either do not use them at all or will only use them in the presence of very complex and expensive safeguards. Here is a partial list:

CHLORATES: The commonly available chlorate compounds are sodium chlorate and potassium chlorate. Both explode so readily when rubbed, ground, or mixed, that professional rocket makers do not use them at all.

POWDERED METALS: Iron, zirconium, lithium, beryllium, magnesium, nickel, boron, and aluminum powders (in particle sizes smaller than iron filings) when poured from one container to another, or shaken, can produce an explosive dust mixture with the air.

The dust of pure iron, zirconium, lithium, beryllium and certain forms of aluminum and magnesium can ignite spontaneously when dispersed in the air.

Beryllium dust or the dust of its oxides, even in very minute quantities, is extremely toxic.

When any of the powdered metals described above are mixed with an oxidizing agent, they can become highly sensitive to impact and shock.

METALLIC SODIUM: It may ignite when exposed to the air if water, even in the form of moisture, is present.

METALLIC POTASSIUM: It spontaneously ignites when exposed to air.

YELLOW PHOSPHORUS: It spontaneously ignites when exposed to air.

FLUORINE: Fluorine is both extremely toxic and very dangerous to handle. The fumes of its gaseous form are deadly and many of its compounds with chlorine, bromine, or iodine are toxic. Fluorine itself will react violently with most organic materials such as human flesh, wood, paper, etc., and with any of the common metals when heated to the ignition temperature.

SULFUR: It will ignite readily under impact or friction when it is mixed with an oxidizing agent. If its dust is mixed with air, a spark will explode the mixture.

POTASSIUM FERROCYANIDE and POTASSIUM FERRICYANIDE: Both react readily with oxidizing agents and will explode if mixed with the chlorates.

NITROCELLULOSE (GUNCOTTON): It will not only burn in the air when ignited, but can also explode, even in the absence of air, when subjected to shock or heat.

NITROGLYCERINE: It is extremely shock-sensitive and detonates readily. It is sensitive to heat as well.

STRONG HYDROGEN PEROXIDE (70% or higher concentration): It will spontaneously set fire to many substances.

HYDRAZINE: It will spontaneously ignite in the presence of many oxidizing agents, such as strong hydrogen peroxide and strong nitric acid. Its fumes are toxic.

FUMING NITRIC ACID: It will spontaneously set fire to many substances. Its fumes are toxic and corrosive.

This partial list should demonstrate to you that it is wise to know what you are dealing with. You can find more complete information in these two books:

Fire Protection for Chemicals, by C. W. Bahme, published by the National Fire Protection Association, 60 Batterymarch St., Boston 10, Mass.

Chemical Safety Data Sheets, published by the Manufacturing Chemists' Association, 1825 Connecticut Ave., N. W., Washington 9, D. C.

Mixing, grinding and fuel-charge forming methods generally become more hazardous if heating or violent treatment is required. A mortar and pestle readily produces enough impact shock to set off many propellant mixtures. Heating a mixture to make a fuel charge that can be poured into a mold produces added hazard, since many mixtures are much more likely to detonate when hot than when cold. Even air bubbles in the formed propellant can cause the rocket to explode. Furthermore, the combustion products of many substances are even more toxic than the substances themselves.

For these reasons, rocket hobbyists should mix their own fuels only if their work can be carried out with the personal guidance of a professional propellant expert.

In time, propellant companies may develop rocket fuel ingredients designed for the use of advanced rocket hobby clubs. However, no such products are now known to be available. Any products of this type offered to the hobbyist should be accompanied by detailed information on the burning rate and shock sensitivity of the propellant at different temperatures and pressures, in the various ingredient proportions for which the materials are suited. The manufacturer should also include instructions for processing the ingredients into the rocket fuel charge, and the precautions that must be taken.

The Charge and Case Design

The advanced rocket hobbyist will find many interesting challenges in the rocket motor design problem. For instance, there is the problem of designing the solid fuel charge.

The two most common types of solid propellant "grains" (fuel charges) are the end-burning grain and the internal-burning grain.

The end-burning grain (Figure 3a) completely fills the motor case; when ignited, it burns as a cigarette burns, from one end inward. This is the simplest type of solid propellant grain and in some ways the safest for amateurs to make. A danger point is that, as the propellant burns, the inside of the motor case is exposed to hot gases which will heat and erode it. These effects may weaken it until it explodes. However, proper insulation within the case can prevent this.

The internal-burning grain (Figure 3b, c, d) has a hole or "perforation" running down its length. Combustion takes place in the perforation, burning out radially. Designing internal-burning grains is much more complex. For

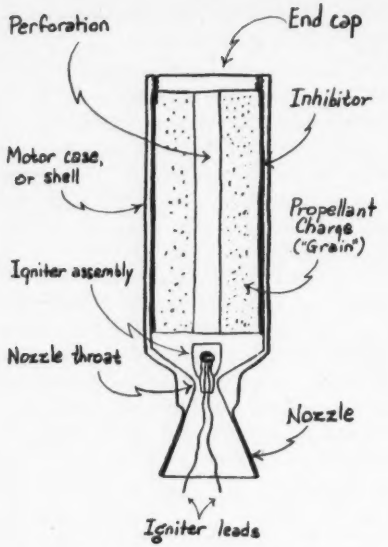


Figure 2. The parts of a typical rocket are shown.

example, the initial cross-section area of the perforation, called the "port," must be at least *three* times the area of the nozzle throat. Otherwise extremely high pressures will be generated and explode the case. A long, narrow grain should have a larger perforation than what is needed in a short, stubby one.

Internal-burning grains should be prevented from burning on their outside surface, that is, "inhibited." Professional rocket makers coat the outside of their grains with various substances, such as epoxy resins, which will limit the burning to the area meant to burn. The inhibitor must be suitable to the propellant type, or it will not do its job.

The effect of high temperature and pressure on the strength of any solid propellant grain must be carefully predicted. If firing the grain causes it to break into pieces or clog the nozzle, explosion is certain.

The ideal fuel charge design is one that will produce gases at a constant rate. The end-burning grain is very satisfactoty in this respect, since the burning surface area remains the same from one end to the other. Internal-burning grains, however, present difficulties. The perforation must be so shaped that the area of the burning surface stays the same all the time that the fuel burns outward.

These are some of the interesting problems of rocket fuel charge design. The design of the rocket case presents further problems.

Before you can design a safe motor case you must know how much gas the propellant you have chosen will generate, and how fast it will be generated.

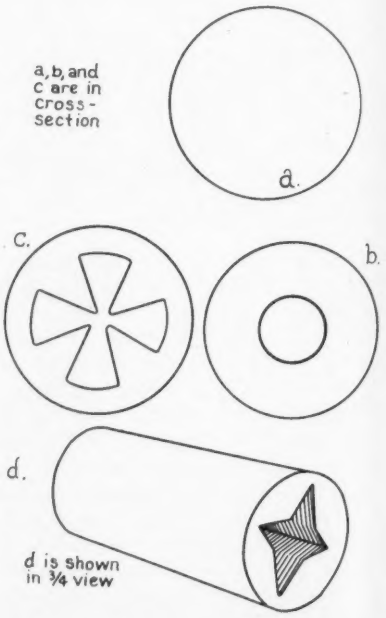


Figure 3. Types of solid propellant grains are shown. The perforations in grains c and d are shaped so as to keep the burning surface area the same throughout the time the fuel is burning out radially.

High temperatures and pressures, which develop quickly within the case once the propellant is ignited, increase the propellant's burning rate and therefore the rate at which gases are generated. When you know the maximum operating pressure within the motor case, you will be able to choose a material and thickness that will withstand this pressure. Since your calculations will be somewhat inexact, and since your rocket motor case material may have hidden flaws, you must allow a liberal margin of safety, *at least a margin of 4.*

What materials should you use? This depends on the power of your propellant, and the size and shape of your rocket case. To select the right material for safe operation, you should find out about the properties, such as tensile strength, compressive strength, and shear strength of the materials you are considering. These properties of strength are not the whole story. Some very strong materials are nevertheless very brittle, and cannot stand the shock of rocket firing. For this reason, never use cast iron. And do not use seamed pipe, which is unreliable. You should ask a person who is experienced in mechanical engineering or a related field to help you with your design, or at least look over your completed design to see if it is reasonably satisfactory.

Once you have chosen the materials, you still have the problem of joining the various parts of the motor case. Particularly important is the method you use to fasten in the head end and the nozzle. A weak joint at either end means that either can become a death-dealing projectile. Rocket manufacturers use various methods to secure strong joints, such as welding, brazing, threading and pinning. In the case of a threaded joint, remember what great pressures you are working with, and seal the threads against gas leakage.

The high temperature at the throat of the nozzle may call for the use of temperature-resistant materials like graphite to keep the throat from burning open to a larger diameter. Efficiency is lost if the nozzle opening is not well matched with the rate at which gases are produced while the fuel charge burns. Insulation to protect the tube from the burning propellant, and the choice of the tube material itself, are good subjects for study if you can learn enough about propellant burning temperatures, heat transfer, and materials to calculate the best design combination.

When you have assembled your rocket case, it is a very good idea to give it a hydrostatic strength test before loading it. A $10 grease-gun can give you pressures up to about 10,000 pounds per square inch, which you can measure with a simple pressure gage.

Finally, there is the problem of designing the rocket igniter. For the igniter material you should choose a substance which is suitable for the propellant you are using. Substances such as fulminate of mercury are too violent in their action, and are likely to damage the propellant grain. Since igniter compositions burn extremely fast, they should be placed in a relatively open area within the motor case or they may rupture the grain.

To be safe, the rocket motor igniter must permit operation from a remote location. This can be arranged by means of a simple electrical circuit. Safer still is an electrical circuit with safety interlocks, such as is described under "Testing Your Rocket."

These problems of rocket design require a lot of knowledge and a lot of work to overcome. The work can be shared among the members of your rocket club. Your rocket club sponsor

and the readings listed below can provide the knowledge.

Many of these readings are highly technical, but all of them contain sections that give important basic information in language any high school student can understand.

HISTORY

V-2, W. Doernberger (Viking Press)
The Men Behind the Space Rockets, H. Gartmann (McKay)
Development of the Guided Missile, K. W. Gatland (Philos. Library)
Rockets, Missiles & Space Travel, W. Ley (Viking Press)
Men, Rockets and Space Rats, L. Mallan (Messner)
The Viking Rocket Story, M. W. Rosen (Harper & Bros.)
The Rocket Pioneers, B. Williams & S. Epstein (Amer. Rocket Society)
Jet Propulsion Magazine, (Journal of the American Rocket Society), November 1955

BASIC ENGINEERING

Handbook of Chemistry & Physics, C. D. Hodgman, ed. (McGraw-Hill)
Handbook of Chemistry, N. A. Lange, ed. (Handbook Publishers, Inc.)
Mechanical Engineers Handbook, L. S. Marks (McGraw-Hill)
Chemical Engineers Handbook, J. H. Perry, ed. (McGraw-Hill)
Fire Protection for Chemicals, C. W. Bahme (National Fire Protection Assn.)
Accident Prevention Manual for Industrial Operations, National Safety Council
An Introduction to Scientific Research, E. B. Wilson (McGraw-Hill)
"*Recent Research on Explosibility of Dust Dispersions*," Industrial & Eng. Chemistry, April 1948

MATERIALS ENGINEERING

Metals Handbook, American Society for Metals
Materials Handbook, G. S. Brady (McGraw-Hill)
Strength of Materials, J. P. Den Hartog (McGraw-Hill)
Engineering Materials Manual, T. C. Dumond, ed. (Reinhold)
Strength of Materials, A. Morley (Longmans, Green)
Theory of Plates & Shells, S. Timoshenko (McGraw-Hill)
Strength of Materials, S. Timoshenko (Van Nostrand)

ROCKETRY AND PROPULSION

"*The Physics of Rockets*," *Amer. Journal of Physics*, Jan. and May, 1947
Aerodynamics, Propulsion, Structures & Design Practice, E. A. Bonney, M. J. Zucrow, C. W. Besserer (Van Nostrand)
Rocket Propulsion, E. Burgess (MacMillan)
Rockets and Guided Missiles, J. Humphries (MacMillan)
"Liquid Propellant Handling, Transfer & Storage," *Industrial & Eng. Chemistry*, April, 1956
"The Toxicity & Health Hazards of Rocket Propellants," *Jet Propulsion*, July-August 1954
Rocket Propulsion Elements, G. P. Sutton (Wiley)
Interior Ballistics of Sold Fuel Rockets, R. N. Wimpress (McGraw-Hill)
Principles of Jet Propulsion, M. J. Zucrow (Wiley)
Rockets, Guns & Targets, J. E. Burchard, ed. (Little, Brown)
Rockets, R. H. Goddard (Prentice-Hall)
Rocket Development, R. H. Goddard (Amer. Rocket Society)

Testing Your Rocket

Thrust Stand Experimentation

Rocket experts often make hundreds of tests on a thrust stand before they ever launch a rocket of new design into the air. The measurements made in these tests help them find ways of improving the performance and reliability of the rocket.

Thrust stand experiments are one of the best ways for you to learn the field of rocketry and experiment with your own design ideas. They give you the opportunity to make measurements and tests on the rocket while it is actually burning. These measurements and tests

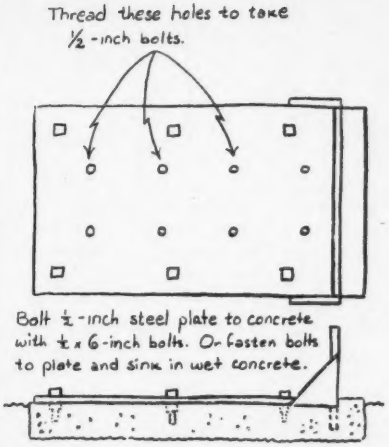

Thread these holes to take
½-inch bolts.
Bolt ½-inch steel plate to concrete
with ½ x 6-inch bolts. Or fasten bolts
to plate and sink in wet concrete.

Figure 4. A basic rocket mooring plate is shown. Your rocket must be firmly fastened down. This mooring plate can be used for experiments in which you are measuring temperature, as in Figure 12, or pressure, as in Figure 13.

cannot be made on a rocket in flight except with the aid of extremely elaborate and costly electronic telemetering equipment few amateurs can build or afford. Tests on the thrust stand can be made safe more easily than flight tests. Small rockets (containing, say, less than a quarter pound of propellant) can be tested on a thrust stand with reasonable safety if the thrust stand is placed in an enclosure in the center of a 5- or 10-acre field. But safe flight tests of even small hobby rockets require so many hundreds of acres of range that it is hardly practical to carry them out anywhere but on a government reservation used for artillery testing or an industrial rocket testing range. Finally, testing your rocket on the thrust stand gives you a much better chance of recovering the parts of a rocket that blows up. These parts may be usable in a later test, and examining them may reveal why the rocket failed.

Professional rocket makers are very careful to protect themselves and others against explosion hazards. They have found that *the only safe way to test a rocket is to assume that it will explode, and take the appropriate precautions.* They choose test locations that are remote from houses and traffic, and encircle them with strong fences that keep out wandering hunters and fishermen and curious passers-by. Second, they build massive test structures of steel-reinforced concrete, and place the rocket to be test-fired inside, fastening it down securely. Third, they use a warning system, a klaxon horn or a bell, which notifies all the people in the area that a test is about to take place and that they must take cover. Fourth, they close the switch that fires the rocket at a location distant from the rocket and protected from any possible explosion. Fifth, the electrical circuit is so arranged that a series of actions, such as closing a succession of switches, is required before the circuit is closed and the rocket fires — this guards against accidental or premature firing.

Some of these precautions may sound too elaborate or expensive for your group. Since you will be working with relatively small rockets, some of the precautions can be modified — a lighter structure instead of the reinforced concrete structures professionals use, a simpler electrical firing circuit. But none of these five precautions should be disregarded.

Figure 4 shows a basic rocket mooring plate, for you to use when you do not plan to measure the rocket's thrust; Figure 5 shows two designs for rocket supports; and Figures 6a and 6b show simple schemes to prevent accidental or premature firing.

Figures 7 and 8 show two rocket firing bays that will confine most of the fragments of a small rocket in the thrust stand area. However, since metal parts

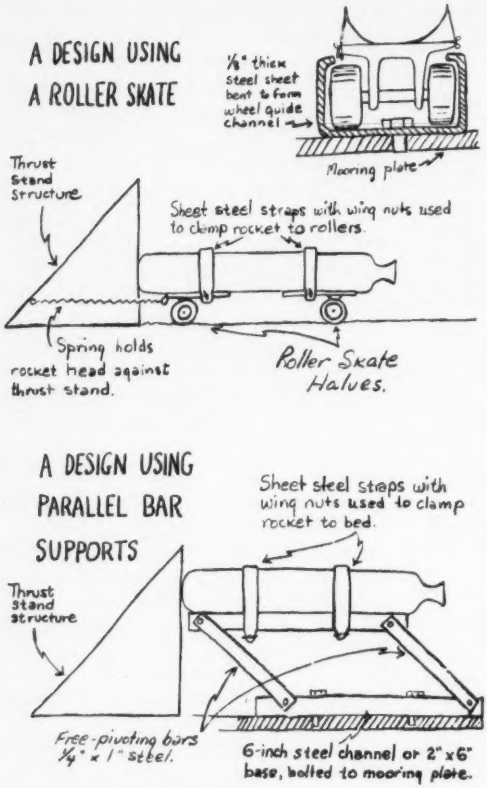

A DESIGN USING
A ROLLER SKATE
⅛" thick steel sheet bent to form wheel guide channel
Mooring plate
Thrust Stand Structure
Sheet steel straps with wing nuts used to clamp rocket to rollers.
Spring holds rocket head against thrust stand.
Roller Skate Halves.
A DESIGN USING
PARALLEL BAR
SUPPORTS
Sheet steel straps with wing nuts used to clamp rocket to bed.
Thrust Stand Structure
Free-pivoting bars ¼" x 1" steel.
6-inch steel channel or 2" x 6" base, bolted to mooring plate.

Figure 5. Designs for thrust stand rocket supports are shown. To measure the thrust of your rocket, you must mount it so that it is free to move a limited distance, on parallel bars or on wheels, as here.

can still bounce to a considerable height out of even these enclosures, you must also protect yourself during a firing. You can do this by digging a foxhole, which should be covered by a ⅛-inch sheet of iron; or you can construct a covered barricade of logs or railroad ties. Of course either of these shelters should be well away from the firing bay.

You should think of your rocket firing range as very much like a rifle range, and keep similar safety rules. The principal difference you should keep in mind is that you are burning much larger amounts of propellant than any rifle cartridge contains. And the layout should provide protection in all directions from the rocket, since explosions must be expected.

Some communities, perhaps yours, are making plans now to build hobby rocket test ranges with all the safeguards provided. Look into this.

Every community has explosives handling laws that require public authorities to approve the firing of experimental rockets. Go to your fire marshal and ask him to approve the design of your rocket test structure. He will tell you what supervision is required when you make your tests.

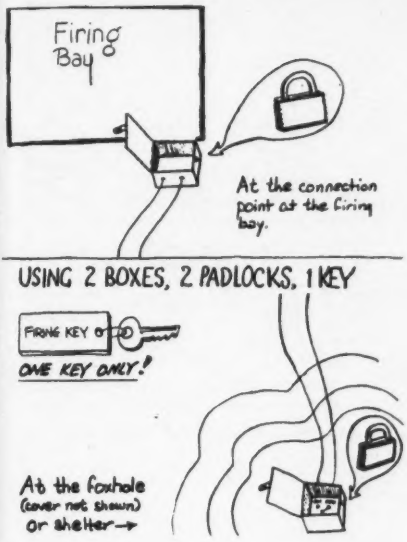

Firing Bay
At the connection point at the firing bay.
USING 2 BOXES, 2 PADLOCKS, 1 KEY
FIRING KEY
ONE KEY ONLY!
At the foxhole (cover not shown) or shelter

Figure 6a. This firing system should give positive safety protection, keeping others from setting off the rocket while the firing officer is making connections at the firing bay. Enclose the firing switch (in your foxhole or shelter) and the electrical connections (at the firing bay) in strong wooden boxes with lids. Lock the lids with two locks that can only be opened by one key. To begin the test, the Firing Officer sets the firing switch in the OFF position, and locks the switch box. Taking the key with him, he goes to the connection box at the firing bay. He unlocks it, makes the necessary connections, and locks it again. Then he returns to the foxhole or shelter, unlocks the switch box, and is ready to fire.

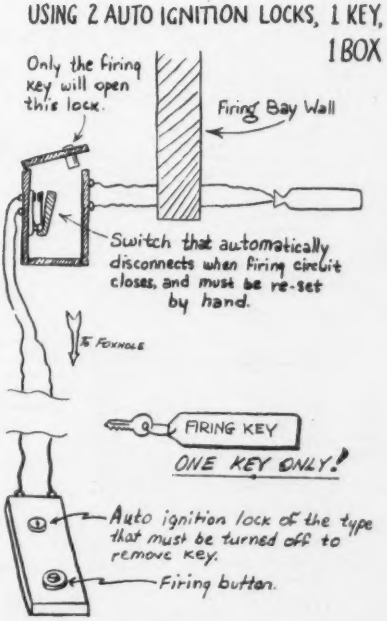

USING 2 AUTO IGNITION LOCKS, 1 KEY, 1 BOX
Only the firing key will open this lock.
Firing Bay Wall
Switch that automatically disconnects when firing circuit closes, and must be re-set by hand.
To Foxhole
FIRING KEY
ONE KEY ONLY!
Auto ignition lock of the type that must be turned off to remove key.
Firing button.

Figure 6b. This safety firing system is even better than the one shown in Figure 6a, but may be harder to put together.

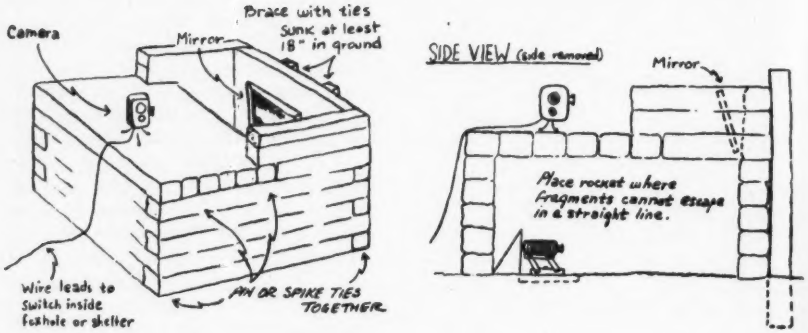

Camera
Mirror
Brace with ties sunk at least 18" in ground
Wire leads to switch inside foxhole or shelter
PIN OR SPIKE TIES TOGETHER
SIDE VIEW (side removed)
Mirror
Place rocket where fragments cannot escape in a straight line.

Figure 7. This sketch suggests the design of a firing bay for use with small rockets (up to ¼ pound of propellant). Fasten the railroad ties firmly together.

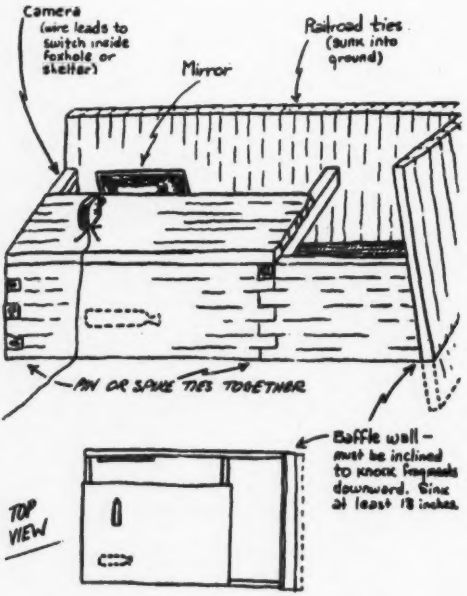

Camera (wire leads to switch inside foxhole or shelter)
Railroad ties (sunk into ground)
Mirror
PIN OR SPIKE TIES TOGETHER
Baffle wall — must be inclined to knock fragments downward. Sink at least 18 inches.
TOP VIEW

Figure 8. This is an improved design for a firing bay. Propellants which produce much smoke may make photography difficult in the firing bay shown in Figure 7. This improved design, although more difficult to build, allows the smoke to vent and therefore may give you better pictures. Note that the height of the various walls and the placement of the rocket have to be carefully adjusted so that fragments of an exploding rocket cannot escape in a straight line. A high pile of sand may be substituted for the inclined baffle wall.

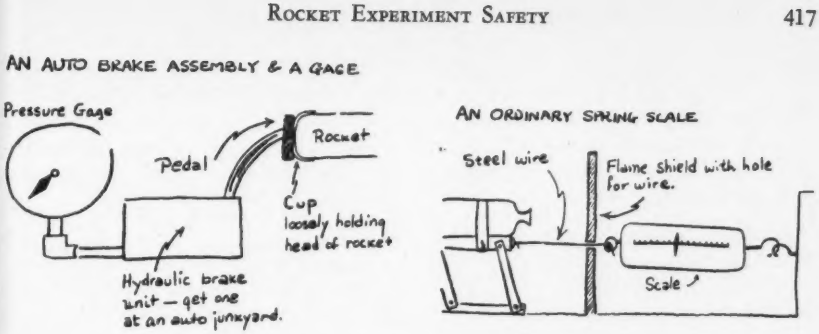

AN AUTO BRAKE ASSEMBLY & A GAGE
Pressure Gage
Pedal
Rocket
Cup loosely holding head of rocket
Hydraulic brake unit — get one at an auto junkyard.
AN ORDINARY SPRING SCALE
Steel wire
Flame shield with hole for wire.
Scale

Figure 9. Two test rigs for taking thrust measurements are shown.

When your rocket is fired you may simply want to watch, or you may want to make measurements in some recorded form. If you want to watch, do it by positioning a pair of mirrors so that you can see the rocket without getting in the line of fire. The same mirror arrangement can protect your home movie camera if you are making a record of the firing. You can make records of a thruststand firing in several ways:

To find out how long the rocket burns, you can mount a home movie camera near the rocket. By dividing the frames-per-second speed of the camera into the number of frames of film that show the rocket actually firing, you will arrive at a good close estimate. A more exact method to find the burning time is to put an electrical clock with a sweep-second hand in the camera's view, along with the rocket. It may be necessary to glue a small triangle of paper on the tip of the clock's second hand, to be sure the time record will be visible on the movie film.

Since the camera must be placed closer than it is safe for you to be when the rocket fires, it will be necessary for you to work out a way of starting and per-

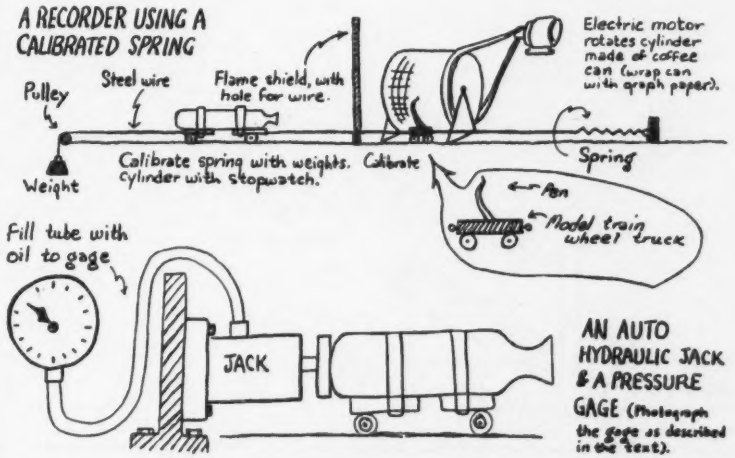

A RECORDER USING A CALIBRATED SPRING
Pulley
Steel wire
Flame shield, with hole for wire.
Electric motor rotates cylinder made of coffee can (wrap can with graph paper).
Weight
Calibrate spring with weights. Calibrate cylinder with stopwatch.
Spring
Pen
Model train wheel truck
Fill tube with oil to gage
JACK
AN AUTO HYDRAULIC JACK & A PRESSURE GAGE (Photograph the gage as described in the text).

Figure 10. Here are two more test rigs for measuring thrust.

haps stopping the camera from a distance. An electric solenoid or a mousetrap can be used to supply the energy to push the camera starter button, if you do not want to modify the camera mechanism itself.

A movie camera can also provide a record of other measurements. Indicating-type instruments, with dials or pointers, such as are shown in Figures 9, 10, 12, and 13, can be photographed during the firing time in the same way you photographed the electric clock. Or, if you do not wish to use a movie camera, you can fit a pen to the pointer of the indicating instrument and make a direct record on graph paper. If you will mount the graph paper on a rotating cylinder, this will give you the best results. Start the cylinder rotating before the rocket fires, so that the pen will draw a "zero line" on the paper. Then, as the rocket fires, the pen will move up on the graph to give a continual record of the changes that occur during the firing. By changing the pulleys that drive the cylinder you can make the graph paper move past the pen at the right speed. By previously timing the movement of the cylinder between two marks on the graph paper you can find out how many inches of graph paper equals a second of time for a particular pulley arrangement.

Set-ups for taking some of the important rocket motor measurements are shown in Figures 9 through 13.

Flight Tests

Measuring the performance of your rocket in flight is quite difficult. Taking motion pictures will provide a record that will allow you to calculate acceleration and velocity for the first few seconds of flight, but will usually permit only a small part of the flight to be followed. If you and your friends have exceptional skill in following the rocket, you can calculate maximum height by the use of two surveyor's theodolites located some distance apart. The fact that the rocket does not ascend in an exact vertical path (rockets rarely do unless equipped with guidance controls) will give you some difficulty. With height, burning time, and time of flight known, and the total impulse determined in thrust stand tests, you may be able to find the effect of air drag by laborious calculations.

In general, worthwhile experimentation through flight testing will require the combined skills of an unusually ad-

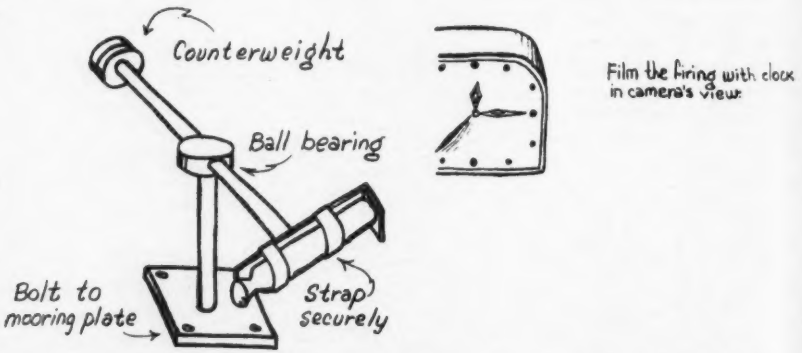


Figure 11. Here is how to measure the total impulse of your rocket. Get the speed of rotation by filming the firing with an electric clock in the camera's view. Calculate the angular inertia of the rotating arm assembly to convert the speed in rpm to total impulse.

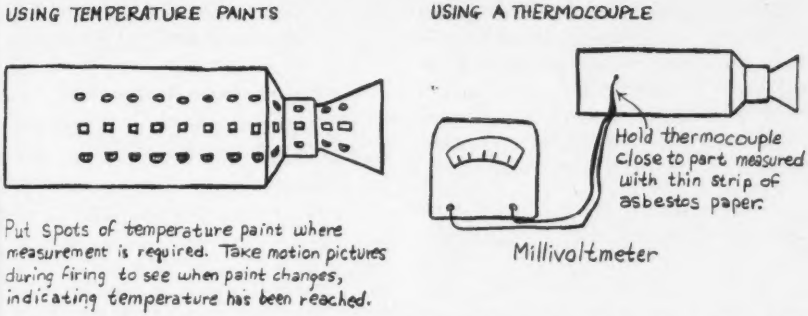

USING TEMPERATURE PAINTS
USING A THERMOCOUPLE
Hold thermocouple close to part measured with thin strip of asbestos paper.
Put spots of temperature paint where measurement is required. Take motion pictures during firing to see when paint changes, indicating temperature has been reached.
Millivoltmeter

Figure 12. You can measure the rocket case temperature in these two ways. Put spots of temperature paint where the measurement is required, then take movies to record when the paint changes its appearance. Since the paints melt and run, put lower temperature paints at the bottom, higher temperature paints at the top. One commercial paint suitable for this measurement is called "Tempilaq." Or use a thermocouple rig.

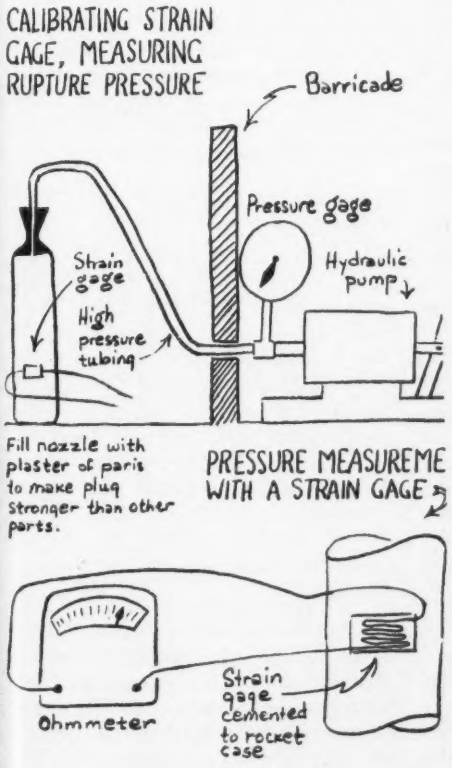

CALIBRATING STRAIN GAGE, MEASURING RUPTURE PRESSURE
Barricade
Pressure gage
Strain gage
Hydraulic pump
High pressure tubing
Fill nozzle with plaster of paris to make plug stronger than other parts.
PRESSURE MEASUREME WITH A STRAIN GAGE
Strain gage cemented to rocket case
Ohmmeter

Figure 13. Take pressure measurements on your rocket case in this way. Pump pressure up, comparing the strain gage reading with the pressure, until the case ruptures. If the case and pump system are *completely* filled with liquid, the explosion effect when the case ruptures will be fairly small.

vanced rocket club. Rocket motor knowledge, aerodynamic design knowledge, and mathematical exertion will be required. If you are fortunate enough to be in such an advanced group, you are already acquainted with more information than this brief article can cover.

In deciding how much range will be needed to flight-test your rocket safely, you should assume that the rocket will fly at 45 degrees to the vertical. This is the course that will take it the greatest distance away from the starting point. A circle with this radius will describe the area from which passers-by must be kept during the test. Air drag can be neglected in making your calculation, but you should take into account the reduced weight of the rocket as the propellant is consumed.

A properly barricaded foxhole fifty yards or so away should give you reasonable protection during the test. You should have a system that will allow you to ignite the rocket without leaving your foxhole.

Several rocket clubs that have carried their rocket development through the thrust stand stage have been able to arrange for flight tests on a military reservation. If your club has done a particularly good job in its earlier work, you may even be able to get a professional rocket flight test installation to make records of your rocket's flight with the advanced tracking instruments they possess. A field trip of this sort can be a very rewarding climax to a rocket club project, if it can be arranged.

You should be well along in your thrust stand studies before you ask permission for such a field trip, since your best admission ticket is your record of good work in design and testing. The public relations officer of your nearest Defense Department installation should be able to put you in touch with the people who can tell you whether such a trip can be arranged.

Organizing a Rocket Club

If you expect to go very far into the rocket hobby, you should see after reading this article that your experiments will require you to make quite a few pieces of test apparatus. While the construction of the apparatus is one of the very interesting parts of amateur rocketry, your primary desire will probably be to make actual tests or rocket motors. By working in a club with a dozen or so partners, you can more quickly complete the construction of this apparatus and start the actual testing of your rocket much sooner. You can also get the benefit of working with others whose knowledge, say, of electronics, or whose skill in construction is more advanced than your own. Even a fairly simple rocket test can keep quite a large group busy in design, construction, testing, and calculation of results.

Here is how you can go about organizing an amateur rocket club:

1. *Get at least one adult sponsor.* Your school science teacher is usually a very good person to ask. He will have useful information on his bookshelf, and he may be able to get shop space and special supplies for the club through the school. The father of one of your club members may be willing to be a sponsor. If he has had scientific training, he will be able to help you in your work. However, if your club wishes to build its own rocket, at least one of your sponsors should be an engineer or scientist.

2. *Organize a safety committee.* Every design and test plan should be checked and approved by this committee. Every hazardous part of your activities should be carried out according to the checklist prepared by this committee.

Checklists save lives. Airline pilots never trust their memories where safety is concerned — before every takeoff a pilot checks off every instrument and control in the order they are listed in his safety manual, item by item.

Members of the safety committee can be the range officers whenever you carry out firing tests, and should be responsible for storage and transportation of propellant and live rockets.

3. *Organize a group of project committees.* Each can carry out a different part of the project you are working on. For example, you can assign one committee to each of these functions:

Plan the tests

Design and build special apparatus

Select and set up instruments

Operate and control the test

Calculate the test results

4. *Find a safe place to work together.*

5. *See the fire marshal.* When you have organized your club and decided what kind of rocket work you want to do, go with your sponsor to your local fire marshal's office and tell him about your plans. He will tell you the local laws you must observe, and whether you must obtain permission each time you plan to make firing tests. He may be able to locate a safe place to make your tests.

6. *Get in touch with others.* See if you can swap ideas with other rocket clubs and perhaps work out plans for interclub competitions. Get in touch with national scientific society chapters in your community, such as the local section of the American Chemical Society. They will have suggestions for you, and may be able to help sponsor you.

You Can Help Develop Amateur Rocketry

The rocket hobby is so new that interclub competition is not yet completely organized. It seems likely that, before long, rules for rocket competition will be established, based on classifying rockets by size and power or use of certain standard components. Model airplane clubs compete on this basis. The result of this kind of organized competition is the development of safer and more versatile designs.

Your club can help by concentrating on a specific size or type of rocket, and refining its designs on the basis of careful experimentation. Your safe experimentation will speed the day when rocket hobby work will be recognized and rocket competition is an activity every community will welcome and be proud of.

Not many years ago "hot-rod" racing was in the same situation that amateur rocketeering is in now. With poor organization or none at all, hot-rodders wasted their energies without clearly defined goals. They also endangered the public because they had not developed rules of safety. There was even talk of banning hot rods.

Today hot-rodders are a recognized hobby group whose experiments are of interest even to auto manufacturers. Because they organized their activities and concentrated on careful testing and competition by class, they have succeeded in developing safer and more versatile designs. They have obtained adult sponsorship and follow safety rules for the protection of themselves and others. They have earned their communities' encouragement and respect.

Your own conduct as an amateur rocketeer can bring about the same result, and contribute to the training of the future scientists and engineers our nation needs.

U. S. Naval Deperming Station Fire

U. S. Naval Base, Charleston, S. C., January 16, 1961

Sparks from a cutting torch were responsible for a fire which started under the wooden deck of a long marginal pier located 1,500 feet out from the shore. Attempts to use hose streams supplied by a fire pump located on the pier and a fireboat moored at the pier were ineffective because of the rapid spread of the fire. Most of the pier, a two-story and attic operations building on the pier, a boat shed, a 50-foot fireboat, and a 40-foot work boat were destroyed with a loss estimated at more than $500,000. Six Navy personnel (3 military and 3 civilian) lost their lives, and five others suffered nonfatal injuries.

This report has been prepared by Mr. Harold S. Walker, P.E. (member NFPA), fire protection engineer, retired, Sixth Naval District. It is based on Mr. Walker's personal knowledge of the property involved supplemented by eyewitness reports.

Pier Construction and Fire Protection

The pier involved in the fire was occupied by the U. S. Naval Deperming Station, located in an isolated spot on the Cooper River at the southern tip of the U. S. Naval Base reservation, Charleston, S. C. Deperming is an operation designed to control the effect of a steel ship's hull on a magnetic field, and deperming is required peri-

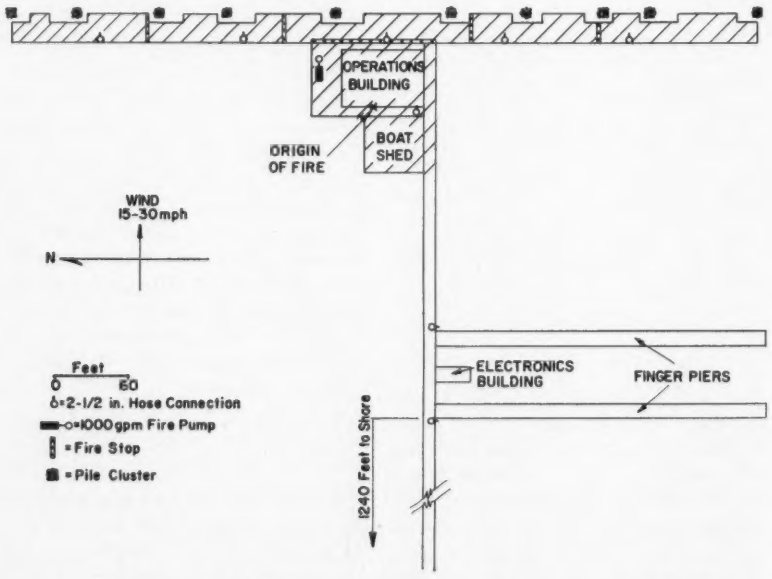


Diagram of U. S. Naval Deperming Station pier. Shaded area was destroyed.

odically to insure accuracy of navigation instruments used on such vessels.

The main pier with its Operations Building and a boat shed were located at the end of a 6-foot-wide approach pier of wooden construction which extended 1,500 feet out from the shore (see diagram). The main pier was parallel to the shore, approximately 600 feet long and 22 feet wide and consisted of wood plank on wood piling, all structural members having been pressure treated with creosote. Two finger piers and an Electronics Building (shown in the photo), which were connected to the approach pier about 240 feet shoreward from the main pier, were not involved in the fire.

The Operations Building was two stories and attic high, of wood construction, approximately 70 feet long by 40 feet wide, and contained an office, living quarters, engine room, battery room, shop, and storage space. The battery room, approximately 20 feet wide by 40 feet long was filled with storage batteries used in the deperming operation. A 1-story open-sided boat shed, 50 feet long and 50 feet wide, attached to the shore side of the main pier, housed a 50-foot fireboat and a 40-foot work boat.

Pier Fire Protection

The primary available fire protection was a 1,000-gpm Diesel-driven salt water fire pump located on the pier adjacent to the Operations Building. This pump supplied eight 2½-inch hose connections through 3-inch water mains. There was also a 500-gpm portable fire pump at the south end of the pier. The 50-foot fireboat was equipped with a 1,500-gpm gasoline-engine-driven fire pump supplying two deck guns. The main pier was not accessible to land-based fire apparatus. The nearest fire hydrant on the Naval Base water system was 6,000 feet distant. Four tugboats equipped for fire fighting were available from the Naval Shipyard, 20 to 30 minutes running time away.

Four transverse fire stops of double plank construction were installed at intervals under the main pier and another separated the main pier from the section on which the Operations Building was erected (see diagram). Fire stops extended down to low water level. There were 21 openings with covers in the deck of the main pier to provide access to the underside for fire fighting.

There was an adequate supply of portable fire extinguishers, including one wheeled 50-pound carbon dioxide unit. There were no special nozzles or other appliances to facilitate under-deck fire fighting but the rapid spread of this fire would have precluded their use. Besides the local evacuation alarm bells, there was no fire alarm system, and the only means of communicating with the Naval Base fire department was by telephone or short-wave radio.

The Fire

An enlisted man was using a cutting torch at a noncombustible welder's table on the deck just outside the west side of the Operations Building. Suddenly he noticed smoke coming up through the cracks between the planks in the pier deck adjacent to the building. He immediately sounded the evacuation alarm and with other personnel attempted to fight the fire. According to newspaper reports he sounded the evacuation alarm at 2:51 P.M., but the telephone alarm to the fire department was not recorded until four minutes later, having been turned in presumably by the officer-in-charge who, in so doing, lost his life.

In the meantime, driven by a stiff breeze which gusted up to 30 mph, the

fire spread below and above the deck with incredible rapidity. The pier fire pump and the pump on the fireboat were started, several hose streams and one of the deck guns on the fireboat were brought into play, but all attempts to extinguish the fire proved futile, and within three or four minutes personnel were forced to abandon all fire fighting efforts due to heat, smoke, and flames. One witness stated that within a matter of six or seven minutes of the discovery of the fire, all electrical circuits to the Operations Building were out, the large storage batteries in the battery room began to rupture due to the heating of battery fluid, and a few minutes later, tanks and drums of flammable liquids stored on the deck adjacent to the Operations Building began rupturing.

The substructure fire stops proved to be of limited value because of the intensity and rapid spread of the wind-driven fire. The stop which ran lengthwise of the pier (separating the main pier from the section on which the Operations Building and the fire pump were erected) may have retarded the fire momentarily in its initial stages. In so doing, however, it apparently deflected the heat and fire upward into the building through pipe and cable openings, and into the area where the fire pump was located. At the same time the fire spread against the wind into the boat shed making further operation of the fireboat impossible.

The Naval Base fire department responded with two 750-gpm pumpers and ten civilian fire fighters. This equipment could not be utilized because the long approach pier was too narrow for fire apparatus and because the nearest water supply for pumper suction was approximately 600 feet off shore over mud flats. Three tugboats and one sea-going tug were dispatched from the Naval Shipyard on request of the fire chief and arrived 20 to 25 minutes later. These took over fire fighting operations but had little effect on the progress of the fire, fed by the creosoted and oil-soaked wood of the pier structures and tons of heavily insulated electric cable stored on the pier.

Loss of Life and Rescue Operations

Six Navy personnel (3 military and 3 civilian) were trapped by the fast spreading flames, presumably at their fire duty stations on the pier or within the Operations Building. These included the officer-in-charge who, after getting fire fighting operations under way, is presumed to have gone to his office on the second floor to call the fire department. The bodies of five of the six victims have been recovered from the river; four were badly burned. Of the survivors, some made their escape via the approach pier; others, most of them suffering from burns, jumped into the river.

A privately owned tug and motor boat were operating about 600 feet south of the pier when the tug captain observed the fire in its early stages. The motorboat pulled two of the survivors from the water and transferred them to the tug while the tugboat crew picked up two others from the water and three from the ends of the burning pier.

The Cause

Sparks from a cutting torch fell through cracks between the deck planks and apparently caused the fire. They may have ignited the heavily creosoted combustible structural members or waste material under the pier deck. It is also possible that the sparks may have fallen into a wooden cable trough beneath the deck which was approximately three feet wide, six inches deep, and contained various types of cable.

The News and Courier

Fire shown burning from end to end of the 600-foot-long unsprinklered wooden main pier originated in the substructure in the approximate area being attacked by the fireboat at left. It was on this part of the pier that the six victims were trapped after manning their fire-duty stations.

Hose lines supplied by a pier fire pump and a small fireboat stationed at the pier could be used for only about four minutes before wind-driven flames forced everyone to flee.

Subsequent fire fighting was done entirely from boats. Land-based equipment responded but could not be used. The 1,500-foot-long approach pier was too narrow for motorized apparatus, there was no hydrant system on shore and the nearest pumper suction was 600 feet from the shore line across mud flats.

Extent of Damage

The pier, Operations Building, and boat shed were a total loss amounting to approximately $150,000 for the pier and buildings, $350,000 to contents and equipment, and $50,000 to the fireboat and work boat. Replacement value may be higher.

Conclusions

1. Wharf and pier structures with decks of plank on heavy timber and wood piling creosoted and oil-soaked, present serious fire hazards. This experience illustrates again the rapid spread of fire in such combustible construction and the difficulty in extinguishing such fires due to the large area involved and the inability to apply hose streams directly on the fire.

2. Automatic sprinklers controlled by a dry-pipe valve are desirable under pier decks where appreciable values are stored or where there is a serious life hazard. Similarly, automatic sprinklers with closed heads should be provided in all superstructures of combustible construction or containing combustible contents.

3. The use of noncombustible deck covering on wood planking probably would have prevented this fire.

Fire Record of Cities, 1960

As Reported by Municipal Authorities

The following tables summarize fire department reports for 1960 in 926* of the 1,004 cities with population over 20,000 in the United States and Canada. Similar statistics have been collected and published in the April QUARTERLIES since 1939.

These tables should not be used as a basis for comparing cities. Any comparison based on these statistics will be misleading if used without a full understanding of the many factors which should be taken into consideration. The principal discrepancy results from the wide variation among fire officials as to what constitutes a fire loss. Certain reports include only insured losses, others only uninsured. Whether or not property is insured has no bearing on the actual value of property destroyed. The chance effect of a single large loss fire, differences in degree of industrialization, in topography, climate and age of cities are some of the factors that influence the fire record. In other words, fire losses reflect the composite results of many factors in addition to fire department efficiency and therefore the practice of making comparisons among different cities based on these data is to be discouraged.

The 1960 census figures have been used in compiling the statistics for this annual study and many new cities, now over 20,000 population, have been added.

*28 of these cities have reported since the calculations have been made. They are listed in the table and identified with a dagger (†) in the dollar loss column.

Fire departments of 754 United States cities and 74 Canadian cities of over 20,000 population have reported to the NFPA in the table on pages 427 to 436 their 1960 estimates for all the following categories: fire loss, fire alarms, building fires, and false alarms.

A total of 779 United States cities reported a fire loss for the year 1960 of $279,326,000. Eighty-one Canadian cities reported a loss of $35,349,000.

The average loss per person in the 779 U.S. cities reporting losses was $4.13, 4.8 per cent more than the $3.94 average loss in 1959. The per capita loss in the 81 Canadian cities reporting losses was $4.72, a 6.5 per cent decrease from 1959.

The average loss per building fire in 711 U.S. cities for 1960 was $1,182, compared with $982 in 1959, and $1,092 in 1958. The average building fire loss in 69 Canadian cities was $1,651 in 1960, $1,387 in 1959, $1,155 in 1958.

The total number of building fires reported by 808 U. S. cities was 297,851, an average of 2.9 fires per 1,000 population, compared with 3.8 building fires per 1,000 population in 1959. Eighty-one Canadian cities reported 22,941 building fires in 1960. The number per 1,000 population was 3.2 in 1960, compared with 3.7 in 1959.

Motor vehicle fires reported by 788 U.S. cities totaled 104,882, an average of 1.28 fires per 1,000 population. Seventy-nine Canadian cities reported 5,862 motor vehicle fires, or 0.79 per 1,000.

(Continued on page 436)

1960 FIRE LOSSES, CITIES OF 20,000 POPULATION AND OVER

As Reported by Municipal Authorities

City	Total Loss in 1,000's	No. Alarms	Bldg. Fires	False Alarms	Bldg. Fires/ 1,000 Pop.
ALABAMA					
Anniston	305a	576	257	57	7.6
Bessemer	58c	372	83	24	2.5
Birmingham	1,188	4,806	1,207	488	3.5
Decatur	184	391	178	27	6.1
Dothan	116	497	210	10	6.4
Florence	...	513	217	29	6.8
Gadsden	217	988	199	104	3.4
Homewood	...	...	...	...	..
Huntsville	123	923	263	49	3.6
Mobile	424d	1,872	716	197	3.5
Montgomery	427i	1,567	569	130	4.2
Phenix City	...	...	...	...	..
Prichard	94	282	136	19	2.9
Selma	252d†	303	201	13	0.7
Tuscaloosa	113	490	220	46	3.5
ALASKA					
Anchorage	219	701	477	9	10.8
ARIZONA					
Mesa	53	453	115	61	3.4
Phoenix	1,930e	5,882	1,444	274	3.3
Tempe	...	263	66	1	2.6
Tucson	634	2,148	470	182	2.2
Yuma	187	396	68	62	2.8
ARKANSAS					
Blytheville	...	...	...	...	..
El Dorado	274	357	118	22	4.7
Fayetteville	26	92	37	1	1.8
Fort Smith	...	...	...	...	..
Hot Springs	137d	405	184	7	6.5
Jonesboro	56	360	202	2	9.4
Little Rock	...	2,068	548	306	5.1
N. Little Rock	236d	1,091	291	59	5.0
Pine Bluff	489c	621	246	19	5.6
CALIFORNIA					
Alameda	338	947	191	128	3.0
Alhambra	89	547	132	99	2.4
Anaheim	71d	928	235	47	2.3
Arcadia	161	650	94	148	2.3
Azusa	23d	158	32	8	1.6
Bakersfield	450d	1,095	172	97	3.0
Baldwin Park	260	610	90	15	2.6
Bellflower	45	391	74	5	1.7
Berkeley	335	2,136	476	111	4.3
Beverly Hills	177	662	92	34	2.9
Buena Park	85	640	126	21	2.7
Burbank	652	1,584	404	116	4.5
Burlingame	298a	524	69	50	2.9
Chula Vista	66	396	88	13	2.1
Compton	270	815	181	36	2.5
Concord	59d	879	68	60	1.8
Costa Mesa	88	476	111	34	3.0
Covina	14	186	53	7	2.7
Culver City	109a	717	121	80	3.8
Daly City	85	1,312	217	239	4.8
Downey	211d	634	270	18	3.3
El Cajon	31	544	92	8	2.4
El Cerrito	73d	336	32	34	1.3
Eureka	54	454	148	110	5.3
Fremont	341a	748	41	28	0.9
Fresno	830	1,569	574	377	4.3
Fullerton	102	443	161	12	2.9
Gardena	...	289	78	9	2.2
Garden Grove	159	993	236	14	2.7
Glendale	178	1,044	347	100	2.9
Glendora	19	187	54	2	2.6
Hawthorne	501†	439	225	7	6.8
Hayward	308	1,238	182	29	2.5
Huntingt'n Pk.	59d	456	162	7	5.4
Inglewood	358	585	209	15	2.7
La Habra	27d	336	75	1	2.7
Lakewood	33	434	93	24	1.4
La Mesa	69d	325	79	4	2.6
La Puente	29	235	51	5	2.1
Lawndale	10	113	23	6	1.1
Lodi	87	227	44	3	2.0
Long Beach	932d	2,351	994	87	2.9
Los Angeles	...	39,600	5,971	2,885	2.4
Los Angeles Co.	...	...	...	...	..
Lynwood	68d	408	60	10	1.9
Manhattan Bch.	48	202	77	4	2.3
Menlo Pk. FPD	314	1,198	201	48	3.1
Merced	74	542	112	38	5.6
Mirada Hills	...	...	...	...	..
Modesto	216	640	174	57	4.4
Monrovia	55	420	100	6	3.7
Montebello	55a	482	105	28	3.2
Monterey	79	195	63	...	2.8
Monterey Park	49	530	114	5	2.9
Mountain View	...	...	...	...	..
Napa	53	276	56	25	2.5
National City	44d	415	108	32	3.3
Newport Beach	383	621	109	10	4.1
Norwalk	164	718	124	19	1.4
Oakland	2,128	7,774	1,758	1,150	4.8
Oceanside	19	333	81	1	3.3
Ontario	81d	915	130	26	2.8
Orange	53	276	90	...	3.2
Oxnard	103a	248	82	17	2.0
Pacifica	11	159	66	12	2.8
Palo Alto	358d	853	293	61	5.6
Paramount	...	...	...	...	..
Pasadena	153	1,233	483	150	4.1
Pico Rivera	132	465	57	20	1.2
Pomona	1d	94	13	3	0.2

a. Estimated or subject to change.
c. Insured losses only.
d. Building and contents only.
e. Building and contents estimated or subject to change.
i. Estimated insured buildings and contents losses only.
† Received too late for inclusion in computations.

City	Total Loss in 1,000's	No. Alarms	Bldg. Fires	False Alarms	Bldg. Fires/ 1,000 Pop.
CALIFORNIA (Continued)					
Redlands	153	369	56	6	2.1
Redondo Beach	118	550	136	11	2.9
Redwood City	209	845	107	47	2.3
Richmond	88	1,286	102	115	1.4
Riverside	366d	780	177	43	2.0
Sacramento	1,023d	3,815	872	373	4.5
Salinas	154d	424	128	42	4.4
San Bernardino	373d	1,494	332	106	3.5
San Bruno	94	465	55	7	1.9
San Buenaventura	30	323	189	2	6.5
San Carlos	...	...	...	...	..
San Diego	963e	5,675	1,643	429	2.9
San Francisco	...	14,213	3,081	3,221	4.1
San Gabriel	183	535	77	13	3.3
San Jose	986a	3,911	476	326	2.3
San Leandro	135	1,013	182	9	2.8
San Luis Obispo	29	258	44	10	2.1
San Mateo	346d	908	278	13	3.9
San Rafael	103a	561	103	31	5.0
Santa Ana	101d	1,754	283	195	2.8
Santa Barbara	224	1,042	224	44	3.7
Santa Clara	151d	1,204	163	39	2.6
Santa Cruz	53	394	80	33	3.1
Santa Maria	42	252	68	4	3.4
Santa Monica	236	1,778	416	229	4.9
Santa Rosa	157d	355	141	46	4.5
South Gate	175d	568	242	19	4.5
S. San Francisco	...	745	72	95	1.8
Stockton	440a	2,485	345	117	4.0
Sunnyvale	123	601	132	4	2.5
Torrance	80	953	262	16	2.6
Vallejo	...	1,018	251	170	4.1
West Covina	26d	383	179	10	3.3
Westminster	...	...	...	...	..
Whittier	15	361	98	5	2.8
COLORADO					
Aurora	60	660	183	17	3.8
Boulder	144	327	123	7	3.3
Colorado Sprgs	67	755	282	59	4.0
Denver	1,750	6,764	2,008	459	4.1
Englewood	90	344	105	5	3.1
Fort Collins	42	231	70	3	2.8
Greely	74d	249	44	4	1.7
Pueblo	157a	2,139	309	95	3.4
CONNECTICUT					
Bridgeport	769a	2,359	618	195	3.9
Bristol	41d	545	160	55	3.5
Danbury	71d	312	116	23	5.1
East Hartford	51d	543	107	33	2.4
East Haven	22a	357	24	8	1.1
Enfield	...	...	...	...	..
Fairfield	592	895	147	13	3.2
Greenwich	1,455†	1,138	214	11	4.0
Hamden	86d	751	80	20	1.9
Hartford	543d	2,739	576	254	3.6
Manchester	...	...	...	...	..
Meriden	171b	501	174	51	3.4
Middletown	...	...	...	...	..
Milford	104	826	66	42	1.6
New Britain	218	913	134	118	1.6
New Haven	927	3,135	688	16	4.5
New London	126	519	125	70	3.7
Norwalk	192a	799	242	32	3.6
Norwich	211	336	122	45	3.2
Stamford	639	872	86	63	0.9
Stratford	146	777	139	...	3.1
Torrington	...	...	...	...	..
Wallingford	120d	299	81	3	2.7
Waterbury	1,273	2,285	549	153	5.1
West Hartford	112a	600	213	24	3.4
West Haven	44	546	93	38	2.2
Wethersfield	...	148	61	2	3.0
DELAWARE					
Wilmington	636	1,355	756	87	7.9
DISTRICT OF COLUMBIA					
Washington	2,525	11,895	2,526	1,402	3.3
FLORIDA					
Clearwater	76	612	78	4	2.2
Coral Gables	77d	931	123	36	3.5
Daytona Beach	179b	508	109	21	2.9
Ft. Lauderdale	133d	672	159	...	1.9
Fort Myers	78	455	84	16	3.8
Fort Pierce	91d†	705	70	9	2.8
Gainesville	166	289	137	23	4.6
Hialeah	110d	870	231	69	3.4
Hollywood	40	491	105	30	3.0
Jacksonville	968	3,776	805	348	3.4
Key West	80	197	29	18	0.9
Lakeland	1,005	508	201	35	4.9
Lake Worth	14d	637	37	8	1.8
Miami	788	3,380	911	150	2.7
Miami Beach	284d	909	360	84	5.7
North Miami	42	768	39	19	..
N. Miami Bch.	9	570	54	16	2.5
Orlando	385	1,117	107	77	1.2
Panama City	131	315	141	8	4.2
Pensacola	274	648	444	1	7.9
St. Petersburg	85e	2,336	317	1	1.7
Sarasota	173	522	133	45	3.9
Tallahassee	570d	651	155	40	3.2
Tampa	2,049a	5,188	1,126	452	4.1
West Palm Bch	437	602	81	26	1.4
GEORGIA					
Albany	499	1,054	423	75	7.6
Athens	74†	532	146	41	4.5
Atlanta	2,068	7,633	1,706	569	3.5
Augusta	266	983	460	63	6.5
Brunswick	47a	233	80	32	3.7

a. Estimated or subject to change.
b. Incomplete.
d. Building and contents only.
e. Building and contents estimated or subject to change.
† Received too late for inclusion in computations.

City	Total Loss in 1,000's	No. Alarms	Bldg. Fires	False Alarms	Bldg. Fires/ 1,000 Pop.
GEORGIA (Continued)					
College Park	167	377	96	22	4.1
Columbus	551	1,345	475	225	4.1
Decatur	52	307	66	5	2.6
East Point	224	506	181	75	5.1
Griffin	73d	284	119	6	5.5
La Grange	60	380	59	15	2.4
Macon	653	948	571	114	8.2
Marietta	35d	440	140	60	5.5
Rome	398	557	223	50	6.4
Savannah	690d	1,860	...	274	..
Valdosta	465	449	188	24	6.1
Waycross	42	364	134	13	5.5
HAWAII					
Hilo	880†	567	68	1	1.1
Honolulu	773	2,838	495	438	1.7
IDAHO					
Boise City	588d	875	108	49	3.1
Idaho Falls	63d	365	193	25	5.8
Pocatello	208	346	114	14	3.7
Twin Falls	...	...	...	...	..
ILLINOIS					
Alton	275	470	247	14	5.7
Arlington Hts.	76	269	64	3	2.3
Aurora	...	...	...	54	..
Belleville	179	342	116	3	3.1
Bellwood	83	138	81	3	3.9
Berwyn	122	1,311	118	9	2.2
Bloomington	72d	1,505	187	49	5.2
Brookfield	...	...	...	...	..
Calumet City	33	681	56	40	2.2
Champaign	262	417	219	29	4.4
Chicago	...	57,925	21,382	17,703	6.0
Chicago Hts.	160d	566	35	68	1.0
Cicero	5,967d	2,314	251	146	3.6
Danville	113	920	97	5	2.3
Decatur	534	951	439	19	5.6
Des Plaines	55	561	16	25	0.5
Downers Grove	...	...	...	...	..
East St. Louis	419	1,253	489	92	6.0
Elgin	214d	640	67	26	1.4
Elmhurst	44d	213	71	5	1.9
Elmwood Park	27a	579	27	2	1.2
Evanston	84	1,573	429	330	5.4
Evergreen Pk.	23	594	91	12	3.8
Freeport	56	883	93	13	3.5
Galesburg	132	324	125	15	3.4
Granite City	...	...	...	...	..
Harvey	25	623	97	24	3.3
Highland Park	522	498	35	6	1.4
Jacksonville	188	248	57	5	2.3
Joliet	613	2,632	273	65	4.1
Kankakee	196	939	59	5	2.1
Lombard	23	187	46	0	1.9
Maywood	73	381	83	6	3.0
Melrose Park	68	279	85	10	3.7
Moline	140	1,030	185	74	4.3
Morton Grove	243	247	70	7	3.4
Niles	36	540	94	26	4.6
North Chicago	81	439	102	7	4.4
Oak Lawn	38	747	73	5	2.7
Oak Park	119	1,072	183	15	3.0
Park Forest	26	353	38	4	1.3
Park Ridge	106	361	23	74	0.7
Pekin	261d	310	108	8	3.8
Peoria	362	1,973	442	207	4.3
Quincy	227	528	129	11	2.9
Rantoul	...	...	...	...	..
Rockford	1,179	1,384	601	117	4.7
Rock Island	349	588	211	26	4.1
Skokie	227d	1,841	335	32	5.6
Springfield	570	1,238	920	42	11.0
Urbana	43	222	87	10	3.2
Villa Park	38d	218	51	4	2.5
Waukegan	128	1,175	373	20	6.6
Wheaton	24d	101	37	7	1.5
Wilmette	65	716	145	14	5.1
INDIANA					
Anderson	836e	1,049	197	76	3.9
Bloomington	54	427	180	18	5.8
Columbus	81	341	134	24	6.5
East Chicago	170d	545	112	115	1.9
Elkhart	56	566	197	53	4.9
Evansville	721	2,071	552	184	3.9
Fort Wayne	466d	2,177	1,055	188	6.5
Gary	1,373	3,621	683	738	3.8
Hammond	329d	3,922	70	192	0.6
Indianapolis	460d	8,483	2,786	315	5.8
Kokomo	547d	676	238	112	4.8
Lafayette	178d	622	158	51	3.7
La Porte	39	402	78	69	3.7
Logansport	61	375	111	25	5.3
Marion	116	658	368	64	9.7
Michigan City	156	693	271	56	7.4
Mishawaka	68	411	183	76	5.5
Muncie	139e	1,078	493	92	7.2
New Albany	133	481	195	36	5.2
New Castle	44	260	57	37	2.7
Richmond	84d	666	332	68	7.5
South Bend	511	1,744	450	355	3.4
Terre Haute	148	1,356	436	75	6.0
IOWA					
Ames	102	254	149	13	5.5
Burlington	300a	470	71	3	2.0
Cedar Falls	70	415	78	...	3.7
Cedar Rapids	359	1,056	361	138	3.9
Clinton	92	1,027	178	18	5.2
Council Bluffs	78	488	157	36	2.8

a. Estimated or subject to change.
d. Building and contents only.
e. Building and contents estimated or subject to change.
† Received too late for inclusion in computations.

City	Total Loss in 1,000's	No. Alarms	Bldg. Fires	False Alarms	Bldg. Fires/ 1,000 Pop.
IOWA (Continued)					
Davenport	203	1,239	80	133	0.9
Des Moines	1,166	2,943	661	168	3.2
Dubuque	115	852	286	38	5.1
Fort Dodge	738	453	151	22	5.3
Iowa City	33	291	116	25	3.5
Marshalltown	28	233	26	8	1.2
Mason City	40	448	86	1	2.8
Muscatine	221	253	105	18	5.0
Ottumwa	171	701	131	5	3.9
Sioux City	131	1,104	400	67	4.5
Waterloo	139	953	390	176	5.2
KANSAS					
Hutchinson	68	562	116	16	3.1
Kansas City	332	1,513	516	52	4.2
Lawrence	197	300	136	18	4.1
Leavenworth	139	350	141	17	6.4
Manhattan	45	165	24	2	1.0
Prairie Village	240	207	67	9	1.7
Salina	48	535	186	17	4.3
Topeka	345	1,284	440	281	3.7
Wichita	626	3,449	655	75	2.5
KENTUCKY					
Ashland	...	...	...	...	..
Bowling Green	167d	436	48	44	1.6
Covington	53	907	367	74	6.1
Lexington	656d	3,621	830	182	13.2
Louisville	...	4,845	1,675	596	4.3
Newport	145	395	217	88	7.2
Owensboro	151a	714	325	1	7.4
Paducah	236	885	280	39	8.1
LOUISIANA					
Alexandria	516d	476	147	56	3.6
Baton Rouge	442	1,876	498	291	3.3
Bogalusa	42	332	123	35	5.8
Bossier City	87	402	130	104	4.0
Gretna	...	...	...	...	..
Houma	171a	101	41	10	1.8
Lafayette	139	296	140	50	3.5
Lake Charles	...	...	...	...	..
Monroe	...	1,074	290	92	5.6
New Iberia	...	...	...	...	..
New Orleans	2,137d	6,599	1,180	182	1.9
Shreveport	890	1,923	711	164	4.3
MAINE					
Auburn	...	575	192	17	7.9
Augusta	126d†	419	132	33	6.1
Bangor	81d	715	294	94	7.6
Lewiston	166	760	155	8	3.8
Portland	174a	1,877	418	138	5.8
South Portland	132	881	185	31	8.1

City	Total Loss in 1,000's	No. Alarms	Bldg. Fires	False Alarms	Bldg. Fires/ 1,000 Pop.
MARYLAND					
Annapolis	109d	248	114	5	4.9
Baltimore	4,491	15,995	3,525	2,151	3.8
Baltimore Cty.	1,535†	8,472	1,852	721	3.8
Cumberland	...	427	171	74	4.4
Frederick	...	...	...	...	..
Hagerstown	387a	443	267	22	7.3
Montgo'y Cty.	1,415	2,937	1,140	56	3.6
Rockville	96	196	87	13	3.3
MASSACHUSETTS					
Arlington	140d	1,250	87	87	1.7
Attleboro	149a	862	55	18	2.0
Belmont	112d	718	188	31	6.6
Beverly	197d	997	185	51	5.1
Boston	...†	20,976	2,096	4,285	3.0
Braintree	89	916	73	50	2.3
Brockton	...	2,450	396	164	5.4
Brookline	325e	1,464	564	146	10.4
Cambridge	766d	5,075	2,627	337	21.9
Chelsea	616	1,231	100	117	3.0
Chicopee	505a	1,040	131	111	2.1
Danvers	85	538	78	13	3.6
Dedham	57a	669	99	42	4.1
Everett	871d	1,016	143	110	3.2
Fall River	216	1,531	346	136	3.5
Fitchburg	100h†	2,153	114	77	2.6
Framingham	...	...	...	...	..
Gloucester	236a	818	173	37	6.7
Haverhill	432d	1,774	315	103	6.7
Holyoke	317	1,265	515	130	9.8
Lawrence	...	1,913	272	98	3.8
Leominster	21d	1,442	102	26	3.6
Lexington	66d	787	127	44	4.4
Lowell	989d†	1,630	490	128	5.3
Lynn	...	3,648	574	327	6.1
Malden	851	1,710	130	84	2.3
Medford	282	2,254	301	213	4.6
Melrose	192d	736	42	63	1.4
Methuen	74	608	96	19	3.4
Milton	84a	686	92	46	3.5
Natick	464	677	123	46	4.3
Needham	37b	636	114	33	4.4
New Bedford	353a	959	324	93	3.2
Newton	513a	1,921	561	122	6.1
Northampton	91d	467	57	44	1.9
Norwood	...	769	100	52	4.0
Peabody	389a	865	197	53	6.1
Pittsfield	76b	981	361	79	6.2
Quincy	647	2,468	405	259	4.6
Revere	557	1,272	64	115	1.6
Salem	210e†	993	362	36	9.2
Saugus	90e†	845	134	50	6.5
Somerville	350	2,335	458	298	4.8
Springfield	874a	4,049	764	505	4 4
Taunton	82	850	216	69	5.2
Wakefield	122	755	75	25	3.1
Waltham	343	1,311	250	103	4.5

a. Estimated or subject to change.
b. Incomplete.
d. Building and contents only.
e. Building and contents estimated or subject to change.
h. Estimated insured losses only.
† Received too late for inclusion in computations.

City	Total Loss in 1,000's	No. Alarms	Bldg. Fires	False Alarms	Bldg. Fires/ 1,000 Pop.
MASSACHUSETTS (Continued)					
Watertown	81	1,172	113	49	2.9
Wellesley	48b	710	46	44	1.8
Westfield	167d	767	114	8	4.3
W. Springfield	265	491	102	44	4.1
Weymouth	160	1,051	82	47	1.7
Winthrop	41b	547	71	9	3.5
Woburn	119	1,295	166	72	5.3
Worcester	1,354a	6,015	1,864	766	10.0
MICHIGAN					
Adrian	23	247	45	17	2.2
Allen Park	86	171	57	0	1.5
Ann Arbor	419	778	264	15	3.9
Battle Creek	403	771	135	106	3.1
Bay City	296	868	349	21	6.5
Berkley	50	269	98	7	4.1
Birmingham	70d	414	101	13	3.9
Dearborn	463	1,053	228	127	2.0
Detroit	10,424e	18,257	5,558	3,846	3.3
East Detroit	109	671	121	15	2.6
East Lansing	55	326	41	14	1.4
Ferndale	125	381	91	51	2.8
Flint	652	2,167	1,077	163	5.5
Garden City	46a	178	55	52	1.4
Grand Rapids	956	1,410	275	57	1.4
Hamtramck	197	681	69	77	2.0
Hazel Park	110	243	91	29	3.6
Highland Park	510	850	181	115	4.8
Holland	17d	150	49	16	2.0
Inkster	56	592	98	20	2.5
Jackson	277	1,736	469	106	9.3
Kalamazoo	331d	1,098	180	39	2.2
Lansing	290d	3,134	381	115	3.4
Lincoln Park	74	596	146	47	2.7
Livonia	120	902	193	49	2.9
Madison Hgts.	76	335	159	11	4.8
Midland	106	351	140	5	5.0
Monroe	299	304	137	18	6.0
Mt. Clemens	205	308	68	24	3.2
Muskegon	95	694	147	83	3.2
Oak Park	54	317	158	3	4.3
Pontiac	671a	1,939	348	229	4.2
Port Huron	238d	581	188	8	5.2
Roseville	342	1,035	226	8	4.5
Royal Oak	170	1,019	203	118	2.5
Saginaw	170f	1,762	171	97	1.7
St. Clair Shore	182	1,797	277	10	3.6
Southfield	104	661	192	14	6.1
Southgate	32	346	55	8	1.9
Warren	135	901	230	51	2 6
Wyandotte	121	458	225	27	5.2
Wyoming	41	422	88	18	1.9
Ypsilanti	34	264	35	5	1.7
MINNESOTA					
Austin	153d	259	114	8	4.1
Bloomington	107	334	143	7	2.8
Brooklyn Ctr.	...	...	...	...	..
Crystal	45	142	26	3	1.1
Duluth	326	1,407	559	40	5.2
Edina	61a	458	25	7	0.9
Mankato	68	220	90	3	3.8
Minneapolis	4,245	4,828	891	482	1.8
Minnetonka	77a	99	27	...	1.1
Moorhead	32	186	30	3	1.3
Richfield	83	298	134	3	3.2
Rochester	420	438	239	68	5.8
Roseville	47	241	11	4	0.5
Saint Cloud	31	294	122	8	3.6
St. Louis Park	100	665	159	4	3.7
St. Paul	1,406a	4,514	1,437	441	4.6
S. Saint Paul	95	138	56	2	2.5
Winona	310d	289	140	29	5.6
MISSISSIPPI					
Biloxi	77	267	94	13	2.1
Clarksdale	61d	257	124	33	5.9
Columbus	2,759d	245	133	8	5.2
Greenville	...	...	...	...	..
Greenwood	26	327	79	47	3.9
Gulfport	...	494	91	22	3.0
Hattiesburg	384	1,202	...	28	..
Jackson	179	1,322	519	193	3.6
Laurel	136	397	173	19	6.2
Meridian	626d	863	475	26	9.6
Natchez	...	622	145	12	4.8
Vicksburg	104	352	159	31	5.5
MISSOURI					
Cape Girardeau	63	301	100	20	4.0
Columbia	289	380	67	5	1.8
Ferguson	13	200	52	2	2.4
Florissant	...	996	83	5	2.2
Hannibal	114†	204	95	7	4.7
Independence	56	569	230	38	3.7
Jefferson City	45d	315	72	17	2.6
Joplin	96d	690	225	42	5.8
Kansas City	3,196	5,373	2,225	429	4.8
Kirkwood	8	314	113	4	3.8
Overland	...	...	...	...	..
St. Charles	...	...	...	...	..
St. Joseph	...	1,246	543	129	6.8
Saint Louis	...	...	...	...	..
Sedalia	...	332	147	12	6.2
Springfield	540e	1,485	424	131	4.4
University City	...	...	...	...	..
Webster Groves	...	...	...	...	..
MONTANA					
Billings	142d	554	80	56	1.5
Butte	...	...	...	...	..
Great Falls	340	845	184	103	3.3
Helena	...	...	...	...	..
Missoula	164d	386	158	30	5.8

a. Estimated or subject to change.
b. Incomplete.
d. Building and contents only.
e. Building and contents estimated or subject to change.
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City	Total Loss in 1,000's	No. Alarms	Bldg. Fires	False Alarms	Bldg. Fires/ 1,000 Pop.
NEBRASKA					
Grand Island	38	882	95	2	3.7
Hastings	14	266	34	8	1.6
Lincoln	137	1,450	437	41	3.4
Omaha	1,500	2,529	1,111	45	3.6
NEVADA					
Las Vegas	446d	1,410	215	92	3.4
Reno	405a	1,361	470	61	7.8
NEW HAMPSHIRE					
Concord	467d	490	182	32	6.3
Manchester	694f	1,338	333	98	3.8
Nashua	201d	709	203	34	5.1
Portsmouth	172	438	...	23	..
NEW JERSEY					
Atlantic City	663	1,057	438	185	7.4
Bayonne	...	1,057	168	75	2.2
Belleville	67d	551	129	39	3.7
Bergenfield	26a†	141	73	1	2.6
Bloomfield	143	756	246	48	4.7
Bridgeton	109	244	132	13	6.3
Camden	1,601d	2,143	412	309	3.6
Carteret	14	125	14	...	0.7
Clifton	9,174	964	131	18	1.6
Cranford	18	327	42	3	1.6
East Orange	228d	1,208	349	56	4.5
Edison	402	627	147	16	3.3
Elizabeth	412d	1,206	282	122	2.6
Englewood	...	347	155	42	5.9
Ewing	15a†	268	48	13	1.8
Fair Lawn	32a	200	33	6	0.9
Fort Lee	...	...	...	...	..
Garfield	136	159	57	0	1.9
Hackensack	488d	582	78	32	2.6
Hillside	71	339	196	...	8.8
Hoboken	320	1,358	330	122	6.8
Irvington	220	898	...	44	..
Jersey City	1,657	4,600	1,427	588	5.2
Kearney	244	550	114	41	3.0
Linden	195	600	155	44	3.9
Livingston	18	372	124	3	5.4
Lodi	...	...	...	...	..
Longbranch	...	...	...	...	..
Lyndhurst	93a	133	49	0	2.2
Maplewood	41	312	91	21	3.8
Middletown	...	...	...	...	..
Montclair	127	728	317	23	7.4
Neptune	...	...	...	...	..
Newark	4,224	8,433	2,287	1,115	5.6
New Brunswick	256d	672	217	55	5.4
New Hanover	...	...	...	...	..
N. Bergen Twp.	411	930	49	39	1.0
Nutley	249	372	93	35	3.2
Orange	115	776	206	90	5.8
Paramus	...	208	51	5	1.8
Parsippany	...	...	...	...	..
Passaic	523c	876	244	84	4.5
Paterson	525d	2,410	1,088	234	7.6
Pennsauken	...	...	...	...	..
Perth Amboy	...	...	...	...	..
Plainfield	66a	663	240	32	5.3
Rahway	25	373	110	10	4.0
Ridgewood	253d	661	196	6	7.7
Roselle	720	320	38	6	1.8
Rutherford	...	...	...	...	..
Sayreville	...	342	65	2	2.9
Summit	...	...	...	...	..
Teaneck	125	914	224	13	5.3
Trenton	309	1,822	349	188	3.1
Union City	533d	1,280	215	60	4.1
Union	562	693	246	1	4.8
Vineland	...	...	...	...	..
Wayne	88	553	107	19	3.6
Westfield	...	427	169	10	5.4
W. New York	139	918	127	24	3.6
West Orange	...	590	126	25	3.2
Woodbridge	...	...	...	...	..
NEW MEXICO					
Alamogordo	...	...	...	...	..
Albuquerque	544†	1,465	589	167	2.9
Carlsbad	45	484	173	14	6.8
Clovis	34	116	65	4	2.7
Farmington	126	329	122	25	5.1
Hobbs	141	343	170	7	6.5
Las Cruces	274	176	54	9	1.8
Roswell	191	590	162	34	4.0
Santa Fe	242	231	85	17	2.4
NEW YORK					
Albany	753d	2,782	890	688	6.2
Amsterdam	54d	290	97	21	3.4
Auburn	55a	403	152	36	4.3
Binghamton	515a	892	213	63	2.8
Buffalo	2,639	5,266	1,425	786	2.7
Cohoes	14	454	62	5	3.1
Elmira	204d	564	147	30	3.2
Freeport	...	...	...	...	..
Garden City	330	349	117	2	4.9
Glen Cove	286	281	96	15	4.0
Gloversville	105	289	79	34	3.6
Hempstead	425	616	170	43	4.9
Ithaca	204	351	93	8	3.2
Jamestown	135d	679	131	31	3.1
Kenmore	324	268	46	8	2.2
Kingston	45d	395	138	36	4.7
Lackawanna	115†	647	102	105	3.4
Lindenhurst	...	...	...	...	..
Lockport	849	617	151	39	5.7
Long Beach	...	...	...	...	..
Middletown	30	263	111	9	4.7
Mineola	...	...	...	...	..
Mount Vernon	485	768	140	55	1.8
Newburgh	103	431	199	51	6.4
New Rochelle	151a	908	367	26	4.8

a. Estimated or subject to change.
c. Insured losses only.
d. Building and contents only.
f. Building and contents incomplete.
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City	Total Loss in 1,000's	No. Alarms	Bldg. Fires	False Alarms	Bldg. Fires/ 1,000 Pop.
NEW YORK (Continued)					
New York City	...	94,135	27,607	16,326	3.5
Niagara Falls	244	1,610	259	153	2.5
N. Tonawanda	52	507	56	22	1.6
Olean	35a	266	72	24	3.3
Oswego	90	307	121	40	5.5
Plattsburg	201	392	224	48	11.1
Port Chester	98d†	221	38	...	1.6
Poughkeepsie	...	...	...	...	..
Rochester	804d	4,577	826	372	2.6
Rockville Ctr.	256†	127	35	8	1.3
Rome	96g	573	185	77	3.6
Schenectady	163	1,036	266	128	3.3
Syracuse	550a	2,513	780	193	3.6
Tonawanda	34	297	93	20	4.3
Troy	146d	1,202	446	27	6.6
Utica	378	872	295	50	2.9
Valley Stream	37	220	80	20	2.1
Watertown	84d	467	115	74	3.5
White Plains	206f	958	251	64	5.0
Yonkers	751d	2,604	378	222	2.0
NORTH CAROLINA					
Asheville	411d	805	81	90	1.3
Burlington	125	689	92	29	2.8
Charlotte	883†	3,650	1,184	763	5.9
Durham	146d	1,140	604	85	7.7
Fayetteville	119	816	241	96	5.2
Gastonia	159	506	213	59	5.7
Goldsboro	22	1,184	241	37	8.3
Greensboro	492d	1,680	587	174	4.9
Greenville	188	369	116	33	5.1
High Point	376	1,059	450	49	7.3
Kinston	300	521	255	57	10.6
Raleigh	316	1,625	511	167	5.4
Rocky Mount	79	457	91	13	2.8
Salisbury	37	305	145	12	6.3
Wilmington	171	653	325	103	7.6
Wilson	89d	431	236	64	8.2
Winston Salem	817	1,775	393	163	3.5
NORTH DAKOTA					
Bismarck	29	307	81	6	2.9
Fargo	115	649	137	21	2.9
Grand Forks	38	308	168	33	4.9
Minot	597	324	108	10	2.9
OHIO					
Akron	719	3,025	752	448	2.6
Alliance	58	250	67	14	2.4
Ashtabula	301a	352	117	11	4.9
Barberton	31	405	114	66	3.4
Canton	631d	953	258	174	2.3
Chillicothe	80	719	88	21	3.7
Cincinnati	1,384	6,835	2,134	825	4.2
Cleveland	4,105	10,796	2,937	1,510	3.4
Cleveland Hts.	113	1,029	200	10	3.2
Columbus	...	14,454	2,375	316	5.0
Cuyahoga Falls	105b	529	144	40	3.0
Dayton	303	7,767	952	439	3.6
East Cleveland	50	487	63	28	1.7
East Liverpool	70	406	112	11	5.0
Elyria	92	350	169	12	3.9
Euclid	45	669	214	10	3.4
Findlay	654	675	120	18	4.0
Garfield Hts.	60	206	76	6	2.0
Hamilton	87	2,533	308	81	4.3
Kettering	32	331	203	5	3.5
Lakewood	518	354	82	78	1.2
Lancaster	31	1,430	93	26	3.1
Lima	433	701	342	30	6.7
Lorain	202b	806	140	47	2.0
Mansfield	...	...	...	...	..
Maple Heights	35	219	80	7	2.5
Marion	112	717	148	22	4.0
Massillon	158d	326	98	50	3.1
Middletown	128	625	202	58	4.8
Newark	239	867	119	193	2.8
Norwood	88	946	144	20	3.8
Parma	109	1,416	58	5	0.7
Portsmouth	197	437	189	47	5.6
Sandusky	431	731	66	35	2.1
Shaker Heights	58	521	450	...	12.3
South Euclid	35	738	146	9	5.3
Springfield	126	3,540	397	74	4.8
Steubenville	71d	578	107	132	3.3
Tiffin	44	136	...	...	..
Toledo	668	2,867	946	305	3.0
Upr. Arlington	16	212	117	3	4.1
Warren	252	679	137	51	2.3
Whitehall	20d	1,613	116	0	5.6
Xenia	24	185	82	13	4.0
Youngstown	332	1,986	438	227	2.6
Zanesville	64d	409	155	58	3.9
OKLAHOMA					
Altus	59	322	49	6	2.3
Ardmore	38d	304	18	7	0.9
Bartlesville	47	415	122	2	4.4
Duncan	57	295	61	16	3.1
Enid	148	478	167	27	4.3
Lawton	437	922	288	25	4.7
Midwest City	131	457	112	5	3.1
Muskogee	236	995	223	49	5.9
Norman	54d	374	63	2	1.9
Oklahoma City	1,039	6,885	1,239	506	3.8
Ponca City	19	514	158	10	6.5
Shawnee	68d	348	54	8	2.2
Stillwater	28d	363	117	0	4.9
Tulsa	578d	4,201	1,111	312	4.2
Hooker	...	...	...	...	..
OREGON					
Corvallis	29d	180	121	1	5.8
Eugene	329	644	362	38	7.1
Medford	280	844	276	21	11.3
Portland	1,543a	5,270	2,145	433	5.8
Salem	8d	468	299	18	6.1

a. Estimated or subject to change.
b. Incomplete.
d. Building and contents only.
f. Building and contents incomplete.
g. Building and contents, insured losses only.
† Received too late for inclusion in computations.

City	Total Loss in 1,000's	No. Alarms	Bldg. Fires	False Alarms	Bldg. Fires/ 1,000 Pop.
PENNSYLVANIA					
Abington	211	380	119	13	2.1
Aliquippa	17d	290	128	23	4.8
Allentown	439	613	296	50	2.7
Altoona	140	790	332	97	4.8
Baldwin	163	54	22	...	0.9
Bethel	66†	10	6	0	0.3
Bethlehem	82	382	152	53	2.0
Bristol	...	...	...	...	..
Butler	30	204	96	10	4.6
Cheltenham	445	256	100	...	2.8
Chester	358d	854	272	109	4.3
Easton	20d	220	86	19	2.7
Erie	339	2,906	911	201	6.6
Falls	1†	7	3	1	0.1
Harrisburg	3,000	809	346	114	4.3
Haverford	...	...	...	...	..
Hazleton	128	188	40	12	1.2
Johnstown	167	910	218	73	4.0
Kingston	8	105	59	...	2.9
Lancaster	232d	581	203	47	3.3
Lebanon	2,184	167	100	4	3.3
Lower Merion	407	1,049	308	2	5.2
McKeesport	26	533	147	109	3.2
Middletown	...	...	...	...	..
Millcreek	...	...	...	...	..
Monroeville	...	...	...	...	..
Mt. Lebanon	27	361	110	0	3.1
New Castle	431d	601	158	48	3.5
New Kensing'n	51	151	54	32	2.3
Norristown	...	...	...	...	..
Penn Hills	...	...	...	...	..
Philadelphia	4,491	17,286	4,336	5,268	2.2
Pittsburgh	2,413	5,833	2,093	1,570	3.5
Pottstown	111	153	53	13	2.0
Pottsville	72d	168	42	11	1.9
Radnor	74	311	142	1	6.5
Reading	...	...	...	...	..
Ross Twp.	...	148	33	8	1.3
Scranton	521d	1,031	291	128	2.6
Sharon	84d	308	69	14	2.7
Spfld-Dela. Co.	25	168	35	1	1.3
Spfld-Mont.Co.	...	...	...	...	..
State College	106	93	46	2	2.1
Upr. Darby T.	259	635	212	4	2.3
Upr. Moreland	...	...	...	...	..
Washington	85	295	133	33	4.7
West Mifflin	...	...	...	...	..
Wilkes-Barre	879	670	175	75	2.8
Wilkinsburg	37	185	38	35	1.2
Williamsport	...	...	...	...	..
York	192	391	180	58	3.3
RHODE ISLAND					
Cranston	401d†	1,878	202	102	3.0
E. Providence	197	1,307	133	64	3.2
Newport	84d	437	260	30	5.5
Pawtucket	322†	3,001	314	213	3.9
Providence	1,231	11,860	469	574	2.3
Warwick	107a	2,832	236	127	3.4
West Warwick	37	468	113	39	5.3
Woonsocket	202	776	193	111	4.1
SOUTH CAROLINA					
Anderson	...	...	...	...	..
Charleston	214	1,283	425	413	6.4
Columbia	403	1,362	682	127	7.0
Florence	106	449	175	69	7.3
Greenville	238	1,209	387	215	5.8
Rock Hill	121	477	81	63	2.8
Spartanburg	450	744	221	127	5.0
Sumter	...	...	...	...	..
SOUTH DAKOTA					
Aberdeen	19d	232	100	2	4.3
Rapid City	1,169d	710	124	15	2.9
Sioux Falls	82	572	179	15	2.7
TENNESSEE					
Chattanooga	545d	2,998	891	673	6.9
Clarksville	...	...	...	...	..
Jackson	245	489	200	21	5.9
Johnson City	234	580	121	18	4.0
Kingsport	5,066	323	78	11	3.0
Knoxville	226	2,182	853	146	7.6
Memphis	3,751	7,535	2,636	249	5.3
Morristown	64a	268	102	4	4.8
Nashville	1,00€d	3,675	1,329	563	7.8
Oak Ridge	12	355	90	18	3.3
TEXAS					
Abilene	146d	1,162	443	89	4.9
Alice	19	140	48	17	2.3
Amarillo	545d	1,528	215	195	1.6
Arlington	105	647	71	37	1.6
Austin	42d	2,346	427	36	2.3
Baytown	41	266	87	0	3.1
Beaumont	350d	1,377	528	79	4.4
Big Spring	164d	354	204	11	6.5
Borger	55†	286	46	8	2.2
Brownsville	70d	438	94	64	2.0
Bryan	90d	217	86	10	3.1
Corpus Christi	245d	1,456	487	161	2.9
Corsicana	330a	864	67	520	3.3
Dallas	3,233d	11,640	2,088	668	3.1
Denison	108g	508	63	27	2.6
Denton	133d	454	109	15	4.1
El Paso	261a	2,728	1,159	205	4.2
Fort Worth	2,480	6,072	1,763	734	4.9
Galveston	...	1,168	337	257	5.0
Garland	111e	512	175	19	4.4
Grand Prairie	106	586	216	5	7.1
Halton City	45d	312	97	9	4.2
Harlingen	72d	446	39	17	0.9
Houston	4,696e	11,159	1,927	2,175	2.1
Irving	285e	618	160	5	3.5
Killeen	56	426	25	4	1.1
Kingsville	...	...	...	...	..
Laredo	69	685	95	69	1.6

a. Estimated or subject to change.
d. Building and contents only.
e. Building and contents estimated or subject to change.
g. Building and contents, insured losses only.
† Received too late for inclusion in computations.

City	Total Loss in 1,000's	No. Alarms	Bldg. Fires	False Alarms	Bldg. Fires/ 1,000 Pop.
TEXAS (Continued)					
Longview	190	763	229	18	5.7
Lubbock	417e	1,727	654	69	5.1
Marshall	79a	443	58	19	2.4
McAllen	29	247	98	4	3.0
Mesquite	51	452	118	0	3.8
Midland	166d	892	231	15	3.7
Odessa	246a	958	378	41	4.7
Orange	68	323	116	40	3.9
Pampa	51	255	103	3	4.2
Paris	48e	398	127	5	6.0
Pasadena	125g	267	94	4	1.6
Port Arthur	334	615	203	85	3.0
San Angelo	154d	553	220	76	3.7
San Antonio	992	6,595	1,410	437	2.4
Sherman	...	...	...	...	..
Temple	360	345	55	39	1.6
Texarkana	124g	467	120	13	3.9
Texas City	110a	462	134	19	4.2
Tyler	70d	648	230	15	4.5
University Prk.	82d	305	40	7	1.7
Victoria	170a	465	170	9	5.2
Waco	485d	1,010	434	20	4.4
Wichita Falls	627	1,505	411	147	4.0
UTAH					
Ogden	64	1,537	205	64	2.9
Provo	45	400	85	7	2.2
Salt Lake City	973	2,687	578	172	3.1
VERMONT					
Burlington	...	558	305	65	8.6
VIRGINIA					
Alexandria	125d	1,187	475	114	5.2
Arlington City	300	1,942	871	37	5.3
Charlottesville	221d	506	146	15	5.0
Danville	206	590	256	61	5.5
Hampton	266	1,232	736	39	8.2
Lynchburg	196	823	231	119	4.2
Newport News	281	2,642	688	125	6.1
Norfolk	1,175	4,988	1,883	771	6.2
Petersburg	71	840	330	89	9.0
Portsmouth	399a	2,346	455	281	4.0
Richmond	445	3,791	1,121	400	5.1
Roanoke	332d	1,360	296	223	3.0
South Norfolk	139	200	115	4	5.2
Staunton	25	161	88	12	4.0
WASHINGTON					
Bellingham	44d	647	347	23	9.4
Bremerton	...	...	...	...	..
Everett	351d	825	237	77	5.9
Longview	39	258	122	48	5.2
Richland	54	342	50	34	2.2
Seattle	466d	5,652	1,063	365	1.9
Spokane	459d	2,459	1,246	219	6.9
Tacoma	691	3,167	1,084	252	7.2
Vancouver	41	408	162	23	5.0
Walla Walla	284	488	74	47	3.0
WEST VIRGINIA					
Yakima	102d	564	256	15	5.9
Charleston	456	1,092	316	218	3.7
Clarksburg	20	213	93	4	3.3
Fairmont	32d	828	140	1	5.1
Huntington	290	1,500	360	149	4.3
Morgantown	21d	177	136	1	6.0
Parkersburg	121d	379	79	42	1.8
Weirton	132	171	44	1	1.6
Wheeling	151	1,916	152	47	2.8
WISCONSIN					
Appleton	52	599	202	49	4.2
Beloit	47	414	148	82	4.5
Eau Claire	198a	567	112	9	2.9
Fond Du Lac	41	296	140	30	4.3
Green Bay	123	1,257	280	49	4.5
Janesville	169	919	160	28	4.5
Kenosha	403	1,253	298	45	4.4
La Crosse	49	849	288	31	5.5
Madison	386	948	396	61	3.1
Manitowoc	47	460	106	53	3.4
Milwaukee	3,031	12,283	1,868	716	2.5
Oshkosh	99a	581	155	34	3.4
Racine	174	2,403	202	85	2.3
Sheboygan	120d	819	546	49	11.9
S. Milwaukee	87	132	51	5	2.5
Superior	128	732	189	67	5.6
Wausau	36	540	197	36	6.2
Wauwatosa	160	955	159	17	2 8
West Allis	40	1,087	122	22	1.8
WYOMING					
Casper	692	637	293	25	7.5
Cheyenne	219	580	131	32	3.0

FIRE LOSSES, CANADIAN CITIES

City	Total Loss in 1,000's	No. Alarms	Bldg. Fires	False Alarms	Bldg. Fires/ 1,000 Pop.
ALBERTA					
Calgary	1,197	2,754	551	437	2.3
Edmonton	678	1,934	649	371	2.4
Jasper Place	40	430	145	0	5.3
Lethbridge	31	284	96	24	2.8
Medicine Hat	13	220	56	42	2.4
BRITISH COLUMBIA					
Burnabay	497	1,051	149	8	1.5
New Westmin'r	833d	646	220	65	5.8
Saanich	43	589	113	...	2.4
Vancouver	5,334a	6,221	1,653	272	4.0
Victoria	562	800	93	98	1.8
MANITOBA					
Brandon	41a	297	130	33	4.7
East Kildonan	16a	136	62	10	2.6
St. Boniface	66d	484	484	...	13.4
Saint James	216	329	74	21	2.2
Saint Vital	60a	168	61	9	2.4
Winnipeg	1,342a	3,575	499	700	1.9

a. Estimated or subject to change.
d. Building and contents only.
e. Building and contents estimated or subject to change.
g. Building and contents, insured losses only.

City	Total Loss in 1,000's	No. Alarms	Bldg. Fires	False Alarms	Bldg. Fires/ 1,000 Pop.
NEW BRUNSWICK					
Moncton	...	...	...	...	..
Saint John	...	1,548	531	243	10.1
NOVA SCOTIA					
Dartmouth	44g	375	49	16	2.0
Glace Bay	60d	217	101	2	4.2
Halifax	377	2,011	1,392	167	15.3
Sydney	57	783	168	137	5.3
ONTARIO					
Barrie	24d	366	18	25	0.8
Belleville	201d	528	312	...	10.7
Brantford	107	461	286	8	5.3
Burlington	213	231	93	2	2.2
Chatham	35d	183	83	8	2.8
Cornwall	135d	432	22	41	0.5
Eastview	...	...	...	...	..
Elliott Lake	85	112	79	2	3.2
Etobicoke	282	1,280	702	50	5.0
Fort William	240d	556	295	...	6.6
Galt	86	373	241	10	8.8
GranthamTwp.	...	...	...	...	..
Guelph	35d	540	19	4	0.5
Hamilton	967d	2,510	553	47	2.2
Kingston	66d	668	372	27	7.2
Kitchener	619	575	132	8	1.8
London	904d	1,181	267	48	2.6
London Twp.	17	88	...	...	..
Niagara Falls	103	227	28	49	1.2
North Bay	47	248	14	11	0.6
Oshawa	115e	628	81	42	1.4
Ottawa	699	3,030	1,308	334	5.0
Peterborough	136d	696	65	6	1.4
Port Arthur	50	545	181	62	4.5
St. Catharines	114d	496	324	32	7.7
Sandwich E.T.	†	81	49	4	2.2
Sandwich W.T.	148	334	63	11	2.4
Sarnia	412d	439	250	9	5.0
Sault Ste. Marie	80e	589	76	25	1.8
Scarborough T.	848d	1,466	345	82	1.9
Stamford Twp.	...	...	...	...	..
Stratford	232	232	27	24	1.3
Sudbury	206d	589	110	58	1.4
Timmins	125	586	108	60	3.8
Toronto	2,564	7,612	2,686	1,018	4.1
Toronto Twp.	212d	480	183	14	3.0
Trafalgar Twp.	192	149	19	6	0.6
Westminster T.	19	46	...	...	..
Windsor	657†	1,226	305	180	2.6
York Twp.	1,916	1,096	182	44	1.5
York E. Twp.	71	450	39	7	0.6
York N. Twp.	872	1,911	763	24	3.4
QUEBEC					
Cap Madeleine	31d	191	110	21	4.2
Chicoutimi	117	215	138	34	4.9
Drummondville	93	181	138	11	5.3
Granby	264	259	185	54	6.0
Hull	603	1,036	424	235	7.7
Jacques Cartier	140	453	220	13	4.9
Jonquiere	...	423	69	181	2.3
Lachine	190	395	273	58	7.0
La Salle	215	308	43	23	1.5
Montreal	6,800	15,870	2,663	5,577	1.9
Montreal Nord	175	442	66	59	1.5
Outremont	111	240	44	24	1.4
Quebec	...	2,333	...	752	..
St. Hyacinthe	81	166	100	54	4.2
Saint Jean	111	52	15	...	0.6
Saint Jerome	101	357	38	110	1.5
Saint Laurent	236	100	32	22	0.6
St. Michel	...	...	...	...	..
Shaw'gan Falls	...	...	...	...	..
Sherbrooke	234d	823	60	174	0.9
Thetford Mines	72	230	22	33	1.0
Three Rivers	130a	448	228	108	4.1
Valleyfield	92	191	30	31	1.2
Verdun	...	...	...	...	..
Westmount	118d	461	40	38	1.5
SASKATCHEWAN					
Moose Jaw	30	342	42	36	1.3
Prince Albert	89	313	29	16	1.3
Regina	317	1,127	147	174	1.3
Saskatoon	315d	836	183	179	2.0

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† Received too late for inclusion in computations.

(*Continued from page 426*)

Fire departments in 813 U.S. cities of more than 20,000 population answered 1,150,857 alarms in 1960. The number of alarms in 84 Canadian cities was 84,577.

In the United States, 806 cities of over 20,000 reported 121,147 false alarms in 1960. This was 10.6 per cent of the total calls. It will be noted that these are "malicious false alarms," not cases where smoke or steam, etc., was honestly mistaken for fire. The 12,870 false alarms reported by 77 Canadian cities were 15.0 per cent of the total calls.

Fire departments have been very cooperative in furnishing fire loss figures. Most of the 78 nonreporting cities did not record their fire experience. A number of loss figures are indicated in the Tables as preliminary estimates.

Index to Volume 54—Quarterly of the NFPA

NOTE: References are to Volume Number and Page. The page numbers in the various issues are as follows:

Pages 1–98: July 1960
Pages 99–206: October 1960
Pages 207–278: January 1961
Pages 279–446: April 1961

A

A, B, C Dry Chemical Extinguishers. By G. E. Manning. Q54:151–153
Acetylene:
Properties of. Q54:269
Transmission Systems for. Q54:269–277
Acoustical Tile, Combustible. *See also Interior Finish, Fiberboard*
Fires Involving. Q54:57–62
Act II — The Indirect Losses. Q54:297–300
Advertisers, Index to. Q54:98, 205, 278, 446
Air-Conditioning Systems. *See Ducts*
Aircraft Carrier Constellation Fire. By Asst. Chief J. T. Ward and Lieut. J. F. Casey. Q54:283–291
Aircraft Crash-Fire-Worthiness. By George H. Tryon. Q54:219–226
Aircraft, Magnesium Fires in. Q54:178
Aircraft Fires:
Crash-Fire Investigation, Need for. Q54:219
Aircraft, Fires Involving:
Andrews AFB, Md., Sept. 11, 1960. Q54:389
Atlanta, Ga., May 23, 1960. Q54:381
nr. Bethel, Me., June 27, 1960. Q54:387
nr. Bracketville, Tex., July 14, 1960. Q54:387
Carswell AFB, Tex., Mar. 8, 1960. Q54:377
nr. Cherry Point, N. C., Mar. 6, 1959. Q54:27
Chicago, Ill., Nov. 24, 1959. Q54:28, 29
Dallas, Tex., Sept. 14, 1960. Q54:389
nr. Daufuskie Island, S. C., July 19, 1960. Q54:388
nr. East Andover, N. H., July 22, 1959. Q54:28
nr. England AFB, La., Jan. 22, 1959. Q54:27
Langley AFB, Va., Oct. 18, 1960. Q54:254
Larson AFB, Wash., Dec. 15, 1960. Q54:385
Lincoln AFB, Nebr., Apr. 15, 1960. Q54:379
Little Rock, Ark., Mar. 31, 1960. Q54:377
London, England, Jan. 7, 1960. Q54:222
nr. Maywood, Ill., July 27, 1960. Q54:254
McGuire AFB, N. J., June 7, 1960. Q54:388
Montego Bay, Jamaica, Jan. 21, 1960. Q54:222
New York, N. Y., May 9, 1960. Q54:380
New York, N. Y., Sept. 14, 1960. Q54:220, 382
New York, N. Y., Dec. 16, 1960. Q54:255
Plattsburgh AFB, N. Y., Aug. 12, 1960. Q54:382
Puget Sound, Wash., Feb. 11, 1960. Q54:253
Ramey AFB, P. R., Feb. 1, 1960. Q54:251
San Diego, Calif., Mar. 28, 1960. Q54:386
Stratford, Conn., Apr. 23, 1960. Q54:379
Toledo, Ohio, Oct. 29, 1960. Q54:254
Walker AFB, N. M., Feb. 3, 1960. Q54:251, 376
nr. Whidbey Island, Wash., May 11, 1959. Q54:28
Aircraft Fuel Servicing, Committee on. Q54:46
Aircraft Hangar. *See Hangars, Aircraft*
Air Foam:
Chemical and Physical Properties of. Q54:135–181
Testing of. Q54: 139–150
Airports, Aircraft Accidents on. Q54:220, 222–224, 251–255, 375–377, 379–386, 389
Air Supported Structures. Q54:46
Alarms Delayed:
Central Station Delayed Notifying F. D. Q54:322
Discoverers Attempted Rescue. Q54:242
Janitor Called Owner, Not Fire Dept. Q54:337
Observers Did Not Call Fire Dept. Q54:246
Occupants Fought Fire, Delayed Alarm. Q54:14, 23, 317, 330, 336, 350, 353, 360
Occupants Smelled Smoke, Did Not Call F. D. Q54: 349
Occupants Thought They Extinguished Fire, Did Not Call F. D. Q54:353
Police Called Rather Than Fire Dept. Q54:23, 358
Telephone Out of Order. Q54:16
Alcohol, Fire Involving. Q54:114–119
Alcohol-Resistant Foam. Q54:135–137, 139
"All-Purpose" Extinguishers. Q54:151–153
Aluminum Fabricating Plant Fire. *See Metalworking*
Ammonium Nitrate, Fires Involving. Q54:321, 372
Amusement and Recreation Places. *See also Bowling Alleys*
Louisville, Ky., Dec. 17, 1960. Q54:352
Aniline Plant Fire. *See Chemical Plants*
Ansul Chemical Company. Q54:154–157, 173
Apartments, Fires Involving:
Ashland, Ky., Feb. 14, 1959. Q54:22, 23
Garden City, N. Y., Dec. 24, 1960. Q54:312
Harrisonburg, Va., Feb. 22, 1960. Q54:245
New York, N. Y., Dec. 16, 1960. Q54:256
Omaha, Nebr., May 28, 1960. Q54:245
Rochester, N. Y., Jan. 1, 1959. Q54:22, 23
St. John's, Nfld., December 16, 1959. Q54:23
Wichita, Kans., Feb. 6, 1960. Q54:245
Appliances, Electrical. *See Electrical Appliances*
Architects, Responsibility for Fire Safety. Q54:363
Argon, Liquid, Handling. Q54:63–70
Armory, Fires in:
Prescott, Ont., Jan. 23, 1960. Q54:315
Vancouver, B. C., Mar. 18, 1960. Q54:351
Arson. *See Incendiary (Suspicious) Fires*
Art Collection, Lost in Fire. Q54:309
Asphalt Coated Metal Roof Deck, Factor in Fire. Q54:62
Asphalt Plant Fire. *See Chemical Plants*
Asphalt Vapor Seal Contributed to Fire Spread. Q54:316, 337
Assembly Occupancies, Sprinkler Performance in. Q54:83–84
Atlantic Research Corp. Q54:406–421
Atmospheric Conditions, Effects of after Nuclear Bomb Attack. Q54:109–110
Atomic Bombs, Fire Effects of. Q54:103–113
Attic and Roof Spaces, Undivided, Fires Spread in. Q54:308, 311–314, 347, 352, 358
Automatic Fire Detection. *See Detection*
"Automatic" Sprinkler Co. of Canada, Ltd. Q54: 195
Automatic Sprinklers. *See Sprinklers*
Automobiles, Fires Involving. *See also Buses, Trucks*
Salinas, Calif., Dec. 18, 1959. Q54:30
West Brooklyn, Ill., Nov. 9, 1959. Q54:30

B

Bakery Fire. *See Food and Food Products*
Barges, Fires Involving. *See Ships and Barges*
Barn, Fire Involving:
Northampton, Mass., May 20, 1960. Q54:334
Baseball Park. *See Outdoor Public Assembly*
Benzene, Sulfonation of. Q54:74
Board of Directors, Meetings of:
Boston, Mass., June 27, 1960. Q54:43
Montreal, P. Q., Canada, May 16, 1960. Q54:43
New York, N. Y., Jan. 19, 1961. Q54:293
Boats. *See Ships and Barges*

Bombs, Nuclear, Fire Effects of. Q54:103–113
Bowling Alley, Fire Involving:
Lowell, Mass., June 25, 1960. Q54:343
Breathing Apparatus Required by Fire Fighters. Q54:60, 116, 290
Bromochlorodifluoromethane. Q54:173–177
Bromotrifluoromethane. Q54:173–177
Brush Fires. *See Forest and Brush*
Bugbee, Percy. Q54:211
Building Densities, Fire Effects of Nuclear Bombs on. Q54:103–113
Building Exits Code. Q54:40, 46, 59, 78
Buildings. *See also Construction*
Fire Losses Classified, 1959. Q54:196–205
Large Loss Fires, 1960. Q54:301–368
Large Loss of Life in. Q54:7–26, 37–41, 235–250, 263–267
Buildings Being Razed, Fires Involving:
New Haven, Conn., Aug. 29, 1961. Q54:324
Buildings, Struck by Falling Aircraft. Q54:28, 251–253, 255–257
Buildings under Construction, Fires Involving:
Calgary, Alta., Oct. 27, 1960. Q54:323
Kelsey, Man., Jan. 30. 1960. Q54:343
Bulk Plant (Flammable Liquid) Fires. *See Petroleum Bulk Plants*
Burns, Skin, Effect of Thermal Energy from Nuclear Bombs. Q54:110–111
Buses, Fires Involving. *See also Automobiles, Trucks*
New Brunswick, N. J., Oct. 9, 1959. Q54:30–32
nr. Phoenix, Ariz., June 8, 1959. Q54:30
Bush, Loren S. Q54:2, 215

C

Canadian Air Force, Royal. Q54:190
Can Fabricating. *See Metalworking (Steel Fabricating)*
Carbon Dioxide:
Efficiency of, Comparative. Q54:173–176
Standard on. Q54:164
Used During Fire. Q54:253
Carbon Dioxide Extinguishment Tests. By E. W. Cousins. Q54:164–172
Canneries, Fires in. *See Food*
Carbon Tetrachloride, Comparative Efficiency of. Q54:173–176
Cardboard Used As Interior Finish, Fire Spread by. Q54:243
Casey, J. F., Lieut. Q54:283
Casualties. *See Fatalities*
Causes, Fire. *See also Specific Causes*
Estimates of Number of Fires by, 1959. Q54:199–200, 204
Large Loss Building Fires, 1953–1960. Q54:303
Large Loss of Life Dwelling Fires, 1959. Q54:11
Large Loss of Life Dwelling Fires, 1960. Q54:239
Cavanagh, Edward F. Q54:283
Ceilings. *See Acoustical Tile, Attic and Roof Spaces, Fiberboard, Wall, and Ceiling Concealed Spaces*
Ceilings, Spacing Sprinklers under. Q54:120–128
Chadwick, Martin. Q54:114–119
Chemical and Physical Properties of Foam. By A. F. Ratzer. Q54:135–138
Chemical Concentrates, Division of Baker Industries, Inc. Q54:135–138
Chemical Foams. Q54:135. 139
Chemical Plants, Fires Involving:
Aniline:
Kingsport, Tenn., Oct. 4, 1960. Q54:264
Asphalt:
Waukegan, Ill., Mar. 3, 1960. Q54:339
Dyes, Organic Chemicals:
Buffalo, N. Y., Aug. 20, 1960. Q54:338
Fertilizer:
nr. Bunkie, La., May 25, 1960. Q54:340
Chemical Process Reactions, Controlling. Q54:72–76
Chemical Reaction, Explosion by. Q54:264
Chemicals and Explosives, Committee on. Q54:45
Children:
Loss of Life in Fires. Q54:10–23, 238–245, 265
Playing with Matches, Fires Caused by. Q54:241, 326
Unattended, Fire Problem of. Q54:9–10, 16, 18, 20, 240, 241, 244
Children's Program on Fire Safety, TV. Q54:79
Chimneys or Flues, Fires Caused by. Q54:11, 13, 18, 244, 251
Chlorobromomethane, Comparative Efficiency of. Q54:173–176
Churches, Fires Involving:
Gainesville, Ga., Feb. 12, 1960. Q54:312
Mulgrave, N. S., May 6, 1960. Q54:360
New York, N. Y., Dec. 16, 1960. Q54:256
Philadelphia, Pa., Mar. 10, 1960. Q54:317
Rochester, N. Y., Jan. 23, 1960. Q54:314
Sumter, S. C., June 10, 1960. Q54:336
Waterbury, Conn., Sept. 7, 1960. Q54:343
Cigarette Lighter, Fire Caused by. Q54:12
Cincinnati, University of. Q54:174
Cities, Fire Record of, 1960. Q54:426–436
City Planning, Nuclear Attack Influence on. Q54:113
Civil Defense, U. S. Q54:103–113
Cleveland, Ohio, Cryogenic Container Disaster. Oct. 20, 1944. Q54:71
Closet, Dwelling, Fires Originating in. Q54:10, 18
Cloth Coating Plants. *See Textiles, Textile Product Plants*
Club, Country, Fire Involving:
Greenwich, Conn., Sept. 5, 1960. Q54:332
Clubs, Night, Fires Involving:
Cleveland, Ohio, Sept. 13, 1960. Q54:315, 353
nr. Las Vegas, Nev., June 17, 1960. Q54:347
Coal Stoves, Fires Caused by. Q54:11, 12, 14, 16
Colleges and Universities. *See Dormitories, Fraternity Houses, Laboratories*
Combustible Metal Fires, Dry Powder Extinguishing Agents for. Q54:154–157
Compressed Gas Association. Q54:67
Compressed Gas Extinguisher, New. Q54:173–177
Compressor, Centrifugal, Explosion in. Q54:41
Concealed Spaces, Factor in Fire Spread. *See Wall and Ceiling Concealed Spaces*
Concentrates, Foam:
Chemical and Physical Properties. Q54:134–138
Testing of. Q54:139–150
Conflagrations:
Derry, N. H., May 6, 1960. Q54:340
Newark, N. J., Apr. 15, 1960. Q54:361
Constellation, Aircraft Carrier, Fire of, Dec. 19, 1960, Brooklyn, N. Y. Q54:283–291
Construction:
Combustible, Factor in Exposure Fire. Q54:306
Factors Influencing Fire Spread. Q54:365
Containers, Cryogenic Fluid. Q54:63–70
Contents, Factors Influencing Fire Spread in Large Loss Fires. Q54:366. *See also Separately Listed Materials*
Contents Hazard Too Severe for Effective Sprinkler Performance. Q54:97
Controlling Chemical Process Reactions. By W. H. Doyle. Q54:72–76
Cooking Equipment. *See Heating and Cooking Equipment*
Cotton Storage Fires. *See Warehouses, Cotton*
Courtyards, Shopping Malls. Q54:129–134
Cousins, E. W. Q54:164–172
Crash Fires, Aircraft. *See Aircraft Fires*
Creosoted Wood, Involved in Fires. Q54:374. 422
Crowds, Handicap During Fire Fighting Operations. Q54:361

Cryogenic Container Caused '44 Catastrophe. Q54:71
Cryogenic Fluids, Handling. Q54:63–70
Cutting and Welding. *See Welding and Cutting*

D

Delayed Detection. *See Detection, Delayed*
Deluge Sprinkler System, Foam-Water in TCA Hangar. Q54:187–195
Department Stores, Hazards of. Q54:131
Detection, Delayed, Factor in Fire Experience. Q54:8–10, 12, 14, 16–20, 60, 116, 236, 239–246, 265, 328, 333, 335–337, 340–345, 350, 351, 353, 355, 358
Detection System, Fire, Automatic
Delay in Notification. Q54:322, 347
Fires Reported by. Q54:319, 346, 348, 355
Detention Homes. *See Prisons*
Dibromodifluoromethane. Q54:173–177
Dibromotetrafluoroethane. Q54:173–177
Dip Tanks, Fire Started at. Q54:318
Distillation, Chemical. Q54:72–73
Distributor Nozzles, Used in Fire. Q54:288
Doors, Fire:
Blocked Open During Fire. Q54:331
Open During Fire. Q54:311
Testing. Q54:52
Dormitories, Detention. *See Prisons*
Dormitories, Fires Involving:
Syracuse, N. Y., Jan. 6, 1959. Q54:25
Doyle, W. H. Q54:72–76
Drainage, Foam Measurements, Test Procedures. Q54:141
Drainage System, Fire in. Q54:253
Drills, Evacuation, Industrial Plants. Q54:56
Drills, Exit, Used Effectively During Fire. Q54:350
Dry Chemical Extinguishers, Multi-Purpose for Class A, B & C Fires. Q54:151–153
Dry Chemicals:
Extinguishing Efficiency, Comparative. Q54:173, 176
Foam Compatible. Q54:160
Industrial Fire Dept., Use of. Q54:50, 53
Navy Research on, Recent. Q54:158–163
Potassium Bicarbonate. Q54:158–163
Dryers, Clothes:
Fires Caused by. Q54:241
Dry Pipe Sprinklers Ineffective. Q54:97
Dry Powder Extinguishing Agents, Special. Q54:154–157
Ducts, Cooking Range, Factor in Fire Spread. Q54:317
Ducts, Heating and Ventilating, Factor in Fire Spread. Q54:314, 316, 337, 344
Ducts, Hot Air, Fire Caused by. Q54:12
du Pont, E. I., de Nemours & Co. Q54:173
Dust Explosion Hazards, NFPA Committee on. Q54:46
Dust Explosions. *See Explosions*
Dust on Structural Members, Spread Fire. Q54:329, 330, 331, 334, 359
Dwellings, Fire Involving:
Appleton, Wis., Oct. 14, 1960. Q54:243
Ashland, Maine, Jan. 20, 1959. Q54:12, 13
Ashland, Mass., Nov. 10, 1960. Q54:244
Barrow, Alaska, Apr. 28, 1959. Q54:16, 17
Batoche, Sask., March 5, 1959. Q54:14
Bauline, Nfld., July 19, 1959. Q54:20
Bay Shore, N. Y., May 1, 1960. Q54:241
Bend, Oreg., Feb. 14, 1960. Q54:240
Boswell, Okla., Jan. 8, 1959. Q54:12
Brandon, Minn., Jan. 7, 1959. Q54:12
Buffalo, N. Y., Oct. 12, 1960. Q54:242
Clear Lake Shores, Tex., Jan. 19, 1959. Q54:12
Cleveland, Miss., Nov. 7, 1960. Q54:243
Cross Hill, S. C., Mar. 15, 1959. Q54:15, 16
Crystal City, Tex., Feb. 21, 1959. Q54:13
Danieltown, Va., March 29, 1959. Q54:16
Detroit, Mich., June 14, 1959. Q54:18
Easton, Maine, Mar. 13, 1959. Q54:14
Elmira, N. Y., July 11, 1959. Q54:18
nr. Evansville, Ind., Mar. 4, 1960. Q54:241
Fillmore, Calif., Mar. 2, 1960. Q54:241
Flint, Mich., Mar. 7, 1959. Q54:14
Havre Boucher, N. S., July 18, 1959. Q54:19
Hill City, Ga., Apr. 25, 1959. Q54:16
Jenkinsville, N. Y., Nov. 10, 1959
Lafayette, Calif., July 4, 1960. Q54:309
Lincoln Heights, Ohio, Jan. 11, 1959. Q54:12
Monneault's Mills, N. B., Nov. 22, 1960. Q54:244
Mt. Clemens, Mich., July 13, 1959. Q54:6, 19
New Orleans, La., Dec. 15, 1960. Q54:244
Noyan, P. Q., Dec. 29, 1960. Q54:244
Ottumwa, Iowa, Oct., 31, 1959. Q54:20, 21
Parkersburg, W. Va., Oct. 25, 1960. Q54:243
Philadelphia, Pa., Mar. 15, 1959. Q54:14
Pilesgrove Twp., N. J., Nov. 6, 1960. Q54:243
Queen Charlotte Islands, B. C., June 27, 1959. Q54:18
Richmond, Calif., July 10, 1960. Q54:241
Roddickton, Nfld., Apr. 30, 1959. Q54:17, 18
nr. South Bend, Ind., Feb. 14, 1959. Q54:13
Superior, Wis., Mar. 16, 1959. Q54:16
nr. Thompson Falls, Mont., Jan. 9, 1960. Q54:239
nr. Trussville, Ala., Feb. 25, 1960. Q54:240
Tuckers Corner, N. Y., Feb. 12, 1960. Q54:239
Vincennes, Ind., Jan. 1, 1959. Q54:11, 12
Wicomoco, Md., Dec. 2, 1960. Q54:244
Winstonville, Miss., Jan. 5, 1959. Q54:12
Dye Manufacturing. *See Chemical Plants*

E

Educational Occupancies, Sprinkler Performance in. Q54:84. *See also Separately Listed Occupancies*
Educators, Responsibility for Fire Safety. Q54:363
Electrical Fires. *See also Causes, Fire*
Equipment, Fires Caused by. Q54:11, 316, 317
Wiring, Fires Caused by. Q54:11, 19, 38, 239, 268, 297–300, 305, 311, 334, 336, 343
Electrical Plant Fires. *See Metalworkers*
Electric Generating Plant Fires:
Ridgefield, N. J., Feb. 7, 1960. Q54:339
Electronic Computer, Lost in Fire. Q54:309
Elevators, Grain, Explosions. Q54:263
Elevator Shafts. *See also Openings*
Fire Originated in. Q54:24
Engineers, Responsibility for Fire Safety. Q54:363
Escapes, Fire:
Not Accessible. Q54:246, 247
Not Provided. Q54:247
Exhibition Hall:
Springfield, Mo., Sept. 7, 1960. Q54:355
Exits:
Inadequate, Cause of Casualties. Q54:9, 10, 17, 20, 22, 24, 25, 38–40, 183–186, 242, 244, 246
Locked, Cause of Casualties. Q54:23, 39, 40
Shopping Malls, Problems of. Q54:129–134
Exits, Shopping Malls, Problems of. Q54:129–134
Expansion Rates, Foam. Q54:135–150
Explosions:
Chemical Reaction. Q54:264
Compression, Centrifugal. Q54:41
Dust, Flour. Q54:320
Dust, Grain. Q54:263
Dust, Plastic. Q54:264
Explosives in Parked Truck. Q54:33
Fatal: Q54:11–13, 16, 17, 20, 23, 33, 41, 71, 243, 253, 263–265, 267, 305, 320, 323, 338
Fire Gas. Q54:12, 40, 119, 307, 346, 349
Flammable Liquid. Q54:17, 33, 41, 251, 256, 264, 265, 318, 340

Gas. Q54:11, 12, 23, 33, 40, 71, 243, 265, 267, 305, 322, 323, 339
Nuclear. Q54:103–113
Rocket. Q54:253
Sprinkler Systems Damaged by. Q54:97, 320, 338
Stoves, Coal. Q54:12, 16
Stoves, Gas-Fired. Q54:23
Stoves, Oil-Fired. Q54:16, 23
Stoves, Wood. Q54:20
Exposure. *See also Outdoor Fire, Spread into Building*
Fires Caused by. Q54:307
Fire Overpowered Sprinklers. Q54:97
Extinguishers:
Compressed Gas Type. Q54:173–177
Dry Chemical, A, B, C. Q54:151–153
Empty at Time of Fire. Q54:336
Hydrostatic Testing of. Q54:52
Standard on. Q54:151
Tests for. Q54:151–153
Training Personnel in Use of. Q54:54
Extinguishing Agent Developments. Q54:135–181
Extinguishing Agents, Toxicity of. Q54:174–176

F

Factory Mutual Engineering Division Tests:
Spacing Automatic Sprinklers. Q54:120–128
Carbon Dioxide Extinguishment. Q54:164–172
Fallout, Radioactive, from Nuclear Bombs. Q54:103–113
False Fronts, Hazard of in Buildings. Q54:131
Fatalities:
Explosions Caused Loss of Life. Q54:12, 13, 16, 17, 20, 23, 28, 33, 36, 41, 114–119, 305, 370
Firemen. Q54:38, 42, 114–119, 350, 352, 356
Occupants Locked in Prison. Q54:38, 39
Public Education Problems. Q54:79–80
Trapped in Aircraft. Q54:27–28, 251–259, 375–390
Trapped in Building by Fire. Q54:9–25, 38, 183–186, 236–248, 331, 352, 356, 422
Trapped in Mine Fire. Q54:42
Trapped in Railroad Fire. Q54:261
Trapped in Ship Fires. Q54:33, 259–261, 283–291, 373, 374
Trapped in Vehicle Fire. Q54:30, 32
Fertilizer, Ammonium Nitrate. *See Ammonium Nitrate Fertilizer Plant Fire. See Chemical Plants*
Fiberboard, Combustible. *See also Interior Finish*
Fire Spread by. Q54:18, 20, 23, 25, 38, 57, 240, 243, 330
Fiberboard Fire in Modern School. By Lawrence R. Woltz. Q54:57–62
Fireboat, Used at Fire. Q54:114–119, 283–291, 422
Firebreaks, Limitations of in Nuclear Bomb Attack. Q54:112
Fire Department, Junior, Hamilton, Ont. Q54:79
Fire Effects of Big Nuclear Bombs. By Frank McNea. Q54:103–113
Fire Fighting, Hazards Following Nuclear Bomb Attack. Q54:103–113
Fire Gas Explosion. Q54:12, 40, 119, 307, 346, 349
Fire Hazards in the Shopping Mall. By John C. Thornton. Q54:129–134
Fire Protection Developments in 1960. By Percy Bugbee. Q54:211
Fire Protection Officials, Responsibility for Fire Safety. Q54:363
Fire Protection Problems of the Future. Q54:217
Fire Record of Cities, 1960. Q54:426–436
Fire Resistive Buildings, Effect of in Nuclear Bomb Attack. Q54:122
Fire Storm, Nuclear Bomb Hazard of. Q54:111–112
Fires and Fire Losses Classified, 1959. Q54:196–205
Fireworks, Cause of Fire. Q54:309
Flammable Liquids: *See also Bulk Plant (Flammable Liquid) Fires and Refinery (Petroleum) Fires*
Explosions. *See Explosions*
Extinguishing Agents for Use on. Q54:135–150, 154–157, 158–163
Fires Caused by or Involving. Q54:9–12, 20, 30, 32, 33, 41, 42, 114–119, 245, 251, 259, 264, 265, 285, 316, 318, 319, 325, 328, 338, 343, 348, 357, 372, 424
Tanks, Inadequate Vents on. Q54:325
Flour Mill Fire. *See Food*
Flue or Chimney Fires. Q54:11, 13, 18, 25, 317
Foam:
Chemical and Physical Properties of. Q54:135–138
Testing of. Q54:139–150
Used During Fires. Q54:251, 253, 255, 256
Foam-Compatible Dry Chemical. Q54:158–160
Foamed Plastics, Fires Involving. Q54:306
Foam, Industrial Fire Dept. Use of. Q54:50, 53
Foam Liquid Concentrates:
Chemical and Physical Properties. Q54:135–181
Testing of. Q54:139–150
Storage in Foam Water Sprinkler System. Q54:192
Foam Rubber, Fires Involving. Q54:39–40
Foam-Water Sprinklers, in TCA Hangar. Q54:187–195
Fog, Effect on Radiation, Nuclear Bomb. Q54:109–110
Food and Food Products Plant, Fires Involving:
Bakery:
Edmonton, Alta., Mar. 1, 1960. Q54:345
Canneries:
New Sharon, Me., Nov. 12, 1960. Q54:337
Port Graham, Alaska, Mar. 3, 1960. Q54:345
Flour and Feed Mill:
Port Colborne, Ont., Oct. 7, 1960. Q54:320
Potato Chip Plant:
Fall River, Mass., Sept. 16, 1960. Q54:346
Food Storage Fires. *See Warehouse, Food*
Forest and Brush Fire:
Napa, Calif., Oct. 15, 1960. Q54:373
Forests, Fire Effects of Nuclear Bombs on. Q54:103–113
Frangible Disc, Cryogenic Containers. Q54:64
Fraternity House:
Stanford, Calif., Aug. 23, 1960. Q54:341
Frozen Sprinkler Systems. Q54:96
Furnace Rooms, Ineffectively Cut Off. Q54:316, 317
Fyr-Fyter Company. Q54:154–157

G

G-1 Powder. Q54:154–157
Gas. *See also Torches, Cutting and Welding*
Acetylene Transmission Systems. Q54:269–277
Explosions. *See Explosions*
Medical, Nonflammable. Q54:68
Gas, Fires Caused by or Involving:
Jets Open, Incendiary Fire Suspected. Q54:12
Liquified Petroleum:
East Chicago, Ind., Mar. 3, 1960. Q54:306
Fort Devens, Mass., July 15, 1960. Q54:227
Merrill, Wis., July 18, 1960. Q54:265
Liquified Petroleum in Tank Car. Q54:35, 372
Liquified Petroleum in Tank Truck. Q54:33
Main Damaged, Responsible for Explosion. Q54:11
Miscellaneous Fires. Q54:10–13, 23, 33, 35, 322, 323, 339, 372
Natural Gas Fires:
Windsor, Ont., Oct. 25, 1960. Q54:267
Gas Holder, Cryogenic, Failure of. Q54:71
Gasoline. *See Flammable Liquids and Stores*
Gas Plant:
Cleveland, Ohio, Oct. 20, 1944. Q54:71
Glasgow Whisky Warehouse Explosion. Q54:114–119
Good Business — This. Q54:49–56
Grandstand:
Memphis, Tenn., Apr. 17, 1960. Q54:369
Guatemala Mental Hospital Fire. Q54:183–186

H

Halls, Dwelling, Fires Originating in. Q54:10
Halogenated Extinguishing Agents. Q54:173–177
Hamburg, Germany, 1943 Fires in During War. Q54:112
Hamilton, Ont., Fire Prevention Program. Q54: 77–80
Handling Cryogenic Fluids. By R. M. Neary. Q54: 63–70
Hangar (Aircraft) Fires. Q54:251
Hangar, Aircraft, Foam Water Sprinklers in. Q54:187–195
Hangar, Aircraft, NFPA Standard on. Q54:190
Hangar, Aircraft, TCA, Foam Water Deluge Sprinklers in. Q54:187–195
Hat Factory Fires. *See Textiles*
Heater, Oil Fired, Defective Control Cause of Fire. Q54:337
Heaters, Wood, Cause of Fire. Q54:243
Heating and Cooking Equipment, Fires Caused by. Q54:11–14, 16, 20, 23, 38, 337
Heights and Areas, NFPA Committee on. Q54:46
Helicopter, Fires Involving. *See Aircraft, Fires Involving*
Helicopter, Rescues by. *See Rescues Accomplished by*
Helium, Liquid, Handling. Q54:63–70
High Piled Stock. *See Storage, Improper, Influencing Fire Spread*
Hospital, Liquid Oxygen, Storage of. Q54:68
Hospitals, Fires Involving:
Guatemala City, Guatemala, July 14, 1960. Q54: 183–186
Port Arthur, Tex., Dec. 31, 1960. Q54:357
Hospital, Mental, Disaster at Guatemala City. Q54:183–186
Hospitals, NFPA Committee on. Q54:46
Hotels, Fires Involving:
Atlantic Beach, N. Y., Mar. 14, 1960. Q54:333
Atlantic City, N. J., Mar. 23, 1960. Q54:306
Bristol, R. I., July 10, 1960. Q54:246
Ellenville, N. Y., June 7, 1960. Q54:347
Eugene, Oreg., Mar. 2, 1960. Q54:358
Hazleton, Pa., Mar. 5, 1959. Q54:23, 24
Lima, Ohio, Dec. 20, 1959. Q54:23
Omaha, Nebr., Feb. 23, 1960. Q54:246
Williamson, W. Va., Oct. 9, 1960. Q54:317
Hotels, Hazard of. Q54:131
Housekeeping, Poor, Contributed to Fire Loss. Q54:305
Humidity, Effect on Radiation Nuclear Bomb. Q54:109–110
Hydraulic Oil Ignited Causing Fire. Q54:340
Hydrogen, Liquid, Handling. Q54:63–70

I

Idle or Vacant Property:
Newark, N. J., Apr. 15, 1960. Q54:361
Incendiary (Suspicious) Fires. Q54:11, 12, 18, 60, 244, 246, 334, 341, 343, 345, 350, 355, 358, 359, 361
Indirect Fire Losses. Q54:297–300
Industrial Fire Safety Program, Procter and Gamble Co. Q54:49–56
Industrial Occupancies, Sprinkler Performance in. Q54:86–94
Industrial Plants. *See Specific Occupancy such as Metalworkers, Textile Working, Woodworking, etc.*
Industrial Truck, Operation of Resulted in Fire. Q54:285, 320
Institutional Occupancies, Sprinkler Performance in. Q54:84
Institutional Properties. *See Mental, Nursing Homes, Prisons, etc.*
Insulation, Combustible, Factor in Fire Spread. Q54: 25, 306, 323, 337, 359
Insulation, Cryogenic Containers. Q54:64–65
Insurance Agents, Responsibility for Fire Safety. Q54:364
Interior Finish, Combustible. *See also Acoustical Ceiling Tile, Cardboard, Fiberboard, and Plywood*
Fatal dwelling fires spread by. Q54:240, 241. 243
Type Not Identified, Factor in Fire Spread. Q54:9, 10, 353
International Acetylene Association, Report of Chemical Acetylene Transmission Committee. Q54:269
Interpretations, NFPA Standards. Q54:47
Interstate Commerce Commission, Cryogenic Fluid Container Specifications. Q54:64–65
Intoxicated Individuals, Fires Involving. Q54:9, 16
Intumescent Powder Extinguishers. Q54:151–153
Ivorydale, Ohio, Procter and Gamble Co. Plant, Fire Prevention Program. Q54:49–56

J

Joisted Ceilings, Spacing Sprinklers under. Q54:120–128
Jones, Clark F. Q54:227
Journal Box, Railroad, Cause of Fire. Q54:34
Junior Fire Department, Hamilton, Ont. Q54:79

K

Keeping People Fire Conscious. By F. S. Staunton. Q54:77–80
Keith, Jas. P., and Associates. Q54:195
Kerosene, Fires Caused by. Q54:11, 12, 20
Kettering Laboratory, University of Cincinnati. Q54:174
Kitchen, Dwellings, Fires Originating in. Q54:10

L

Laboratories, General, Fires Involving:
Narragansett, R. I., Jan. 6, 1959 Q54:297–300
East Chicago, Ind., Mar. 3, 1960. Q54:306
Robins Air Force Base, Ga., Dec. 7, 1960. Q54:340
Laboratory, Private, Damaged in Fire. Q54:308
Ladders, Aerial Collapse at Fire. Q54:317
Lamp, Kerosene, Fire Caused by. Q54:11
Large Loss Fires of 1960. Q54:301–405
Large Loss of Life Fires of 1959. Q54:6–42
Large Loss of Life Fires of 1960. Q54:233
Laws, Fire, Keeping People Conscious of. Q54:77–80
Leather, Leather Products Plant, Fire Involving:
Shoes:
Derry, N. H., May 6, 1961. Q54:340
Library, Private, Lost in Fire. Q54:297–300, 308, 309, 316
Lift Trucks. *See Industrial Trucks*
Lightning Caused Fire. Q54:319, 347
Linde LC-3 Container, Cryogenic Fluids. Q54:64–65
Liquefied Gas, Cryogenic. Q54:63–71
Liquid Argon, Handling. Q54:63–70
Liquid Helium, Handling. Q54:63–70
Liquid Hydrogen, Handling. Q54:63–70
Liquid Methane, Handling. Q54:63
Liquid Nitrogen, Handling. Q54:63–70
Liquid Oxygen, Handling. Q54:63–70
Lithium Fires, Use of Dry Powders on. Q54:155–156
Lith-X, Dry Powder Extinguishing Agent. Q54:156
Living Rooms, Dwellings, Fires Originating in. Q54:10
LP-Gas Tank Truck Fire at Fort Devens. By Clark F. Jones. Q54:227
Lumberyards, Fires Involving:
Louisville, Ky., Mar. 13, 1960. Q54:307
Vancouver, B. C., July 3, 1960 Q54:360

M

Magnesium Fires, Trimethoxyboroxine for. Q54:178–181

Magnesium Fires, Use of Dry Powders on. Q54:153, 155
Maintenance of Sprinklers Inadequate. Q54:97
Malls, Shopping, Fire Hazards of. Q54:129–134
Manning, G. E. Q54:151–153
Matches. *See Smoking, Matches*
McNea, Frank. Q54:103–113
Mearl Corporation, The. Q54:139–150
Mechanical Foam:
Chemical and Physical Properties. Q54:135
Testing of. Q54:139–150
Medical Gases, Nonflammable. Q54:68
Mental Institutions, Fires Involving:
Central Islip, N. Y., Oct. 24, 1960. Q54:318
Northampton, Mass., May 20, 1960. Q54:334
Mercantile Occupancies, Sprinkler Performance in. Q54:85
Mercantile Stores. *See also Shopping Mall, Stores*
Metals, Combustible, Dry Powder Extinguishing Agents for. Q54:154–157
Metalworking Plants, Fires Involving:
Aluminum Fabricating:
Calgary, Alta. Mar. 12, 1960. Q54:337
Electrical Appliance Assembling:
Chicago, Ill., May 3, 1960 Q54:331
Fort Smith, Ark. June 22, 1960. Q54:316
Schenectady, N. Y., July 7 1960. Q54:316
Refining and Smelting (Vanadium):
nr. Albany, Ore., Jan. 31, 1960. Q54:352
Steel Fabricating:
Philadelphia, Pa., Dec. 12, 1960. Q54:305
Phillipsburg, N. J., Feb. 11, 1959. Q54:41
Cincinnati. O., Mar. 29, 1960. Q54:322
Vehicle Assembly:
Masury, Ohio, Oct. 22, 1960. Q54:329
Methane, Liquid, Handling. Q54:63
Met-L-Kyl, Dry Powder Extinguishing Agent. Q54:156–157
Met-L-X Powder. Q54:154–157
Mine Fire, Slate
Mineral Hills, Mich., June 1, 1959. Q54:42
Mines, Coal, Fire Involving:
Logan, W. Va., March 8, 1960. Q54:268
Missile, Fire Involving:
McGuire AFB, N. J., June 7, 1960. Q54:388
Monitor Nozzles, Used in Fire. Q54:288
Montreal International Airport, TCA Hangar at. Q54:187–195
Motor Vehicles, Fires Involving:
New Brunswick, N. J., Oct. 9, 1959. Q54:30–32
nr. Phoenix, Ariz., June 8, 1959. Q54:30, 31
nr. Pottsville, Pa., June 2, 1959. Q54:33
Roseburg, Ore., Aug. 7, 1959. Q54:32, 33
nr. Salinas, Calif., Dec. 18, 1959. Q54:30
West Brooklyn, Ill., Nov. 9, 1959.
Motor Vehicles, Large Loss of Life in, 1959. Q54:29–33
Moving Forward in Fire Protection. By Loren S. Bush. Q54:215
"Multi-Purpose" Extinguishers. Q54:151–153

N

Narragansett Marine Laboratory Fire. Jan. 6, 1959. Q54:297–300
National Electrical Code. Q54:44
Navy Research:
Dry Chemicals, Recent Fire Tests. Q54:158–163
Trimethoxyboroxine for Magnesium Fires. Q54:178–181
Neary, R. M. Q54:63–70
Neill, Raymond R. Q54:178–181
New Compressed Gas Extinguisher. By Fred S. Palmer. Q54:173–177
Newspapers, Fires Starting in. Q54:22
New York Naval Shipyard Fire., Dec. 19, 1960. Q54:283–291
NFPA Board. *See Board of Directors*
NFPA Committee on Aircraft Fueling Servicing. Q54:46
NFPA Committee on Chemicals and Explosives. Q54:45
NFPA Committee on Dust Explosion Hazards. Q54:46
NFPA Committee on Heights and Areas. Q54:46
NFPA Committee on Hospitals. Q54:46
NFPA Standard on Aircraft Hangars. Q54:190
NFPA Standard on Bulk Oxygen Systems at Consumer Sites. Q54:68
NFPA Standard on Carbon Dioxide Extinguishing Systems. Q54:164
NFPA Standard on Nonflammable Medical Gas Systems. Q54:68
NFPA Standard on Portable Fire Extinguishers. Q54:151
NFPA Standard on Sprinkler Systems. Q54:190
NFPA Technical Committee Procedures. Q54:46
Nitrogen, Liquid, Handling. Q54:63–70
Nozzles, Carbon Dioxide. Q54:167
Nozzles, Special Types, Used in Fire. Q54:288
Nuclear Bombs:
Fire Effects of. Q54:103–113
Grounds Bursts of. Q54:103–113
Nursing Homes, Fires Involving:
Glen Ellyn, Ill., Jan. 30, 1959. Q54:37, 38

O

Occupancies, Estimates of 1959 Fire Experience in U. S. by. Q54:197–198, 201–203
Occupancies, Large Loss Fire Distribution in, 1956–1960. Q54:302
Occupancies, List of Large Loss Fires by. Q54:391–405
Occupancies, Sprinkler Performance in. Q54:81–97
Office Building Fires:
Schenectady, N. Y., July 7, 1960. Q54:316
Vicksburg, Miss., Oct. 3, 1960. Q54:308
Office Occupancies, Sprinkler Performance in. Q54:84
Office of Civil and Defense Mobilization, U. S. Q54:103–113
Oil, Explosion of in Compressor. Q54:41–42
Oil Heaters or Stoves, Fires Caused by. Q54:11, 12, 16, 18, 23, 25
Openings, Horizontal, Vertical, Unprotected, Fires Spread Through. Q54:9, 10, 12, 14, 16, 18, 19, 22, 23, 313, 315, 325, 330, 335, 337, 343, 353, 356, 358
Openings, Vertical:
Factor in Life Safety in Buildings. Q54:239, 240, 244, 245, 246
Open Joist Construction, Sprinkler Spacing under. Q54:120–128
Outdoor Fire, Spread into Building. Q54:306, 310, 340, 358, 360, 373
Outdoor Public Assembly:
Memphis, Tenn., April 17, 1960. Q54:369
Outdoor Storage:
Seaford, Del., (Baled Nylon), June 9, 1960. Q54:370
Toronto, Ont., (Auto Parts), Aug. 18, 1960. Q54:370
Ovens, Fires Caused by. Q54:243
Owners, Property Responsibility for Fire Safety. Q54:363
Oxygen, Liquid, Handling. Q54:63–70
Oxygen Systems at Consumer Sites, NFPA Standard on. Q54:68

P

Packing Materials, Combustible, Factor in Fire Spread. Q54:305, 308, 370
Paint Drying Booth, Fire Starting in. Q54:329
Pallets, Wood:
Factor in Fire Spread. Q54:306, 326

Palmer, Fred S. Q54:173
Paper Mills:
nr. Macon, Ga., Dec. 31, 1960. Q54:322
Paper Products Fabricating, Plant Fires:
East St. John, N. B., Mar. 9, 1960. Q54:316
Parking, Fire Problems of. Q54:133
Petroleum Bulk Plants, Fires Involving:
Kansas City, Kans. Aug. 18, 1959. Q54:42
Pine Bluff, Ark., Apr. 14, 1960. Q54:324
Pier and Wharves, Fires Involving:
Charleston, S. C., Jan. 16, 1961. Q54:422–425
Los Angeles, Calif., Mar. 17, 1960. Q54:374
Vancouver, B. C., July 3, 1960. Q54:360
Pipe, Carbon Dioxide Flow Through. Q54:164
Plastics Fabricating Plant, Fire Involving:
Films and Sheets:
Princeton, Minn., July 29, 1960. Q54:327, 328
Plastics, Foamed. *See Foamed Plastics*
Plastics Manufacturing Plant, Fire Involving:
Wilmington, Del., Nov. 8, 1960. Q54:264
Plywood, Fire Spread by. Q53:13, 20
Polar Solvents, Foams for. Q54:136, 139
Polystyrene Foam, Factor in Fire Spread. Q54:306
Portable Fire Extinguishers. *See Extinguishers*
Potassium Bicarbonate Dry Chemical. Q54:158–163
Potassium Fires, Use of Dry Powders on. Q54:155
Potato Chip Plant Fire. *See Food*
Powder Extinguishing Agents, Special Dry. Q54:154–157
Powder, Intumescent Extinguisher. Q54:151–153
Prevention, Fire, Program at Procter and Gamble Plant. Q54:49–56
Printing, Typesetting Plants, Fires Involving:
Chicopee Falls, Mass., Dec. 8, 1960. Q54:328
Kahoka, Mo., Apr. 18, 1960. Q54:359
Prisons, Fires Involving:
Toms River, N. J., Aug. 23, 1959. Q54:39, 40
Wrightsville, Ark., Mar. 5, 1959. Q54:38
Processes, Chemical, Controlling Reaction of. Q54:72–76
Procter and Gamble Co., Fire Prevention Program. Q54:49–56
Propylene Tank Car, Explosion. Q54:34
Protection, Private, Defects Influencing Fire Spread in Large Loss Fires. Q54:367
Protection, Public, Fire:
Apparatus Damaged at Fire. Q53:317
Handicaps Influencing Spread. Q54:331, 362, 368
Inaccessible Due to Water. Q54:320, 422–425
None Available at Fire. Q54:306
Number of Fire Departments. Q54:212
Response Delayed. Q54:243
Weak at Fires. Q54:17, 38, 183–186, 297–300, 327, 330, 337, 340, 347, 358
Protein Base Foams:
Chemical and Physical Properties. Q54:135
Testing of. Q54:139–150
Pumping Foam Liquid Concentrates. Q54:138
Pumps, Fire, Typical Installations. Q54:51
Pumps, Fire, Failure During Fire. Q54:320, 334, 337
Purdue Research Foundation. Q53:173
Purple-K-Powder. Q54:158–163

R

Radiation, Thermal, Effect of Atmospheric Conditions on. Q54:109–110
Radioactive Fallout, from Nuclear Bombs. Q54:103–113
Railroad Rolling Stock, Fires Involving:
Bakersfield, Calif., Mar. 1, 1960. Q54:261
Meldrim, Ga., June 28, 1959. Q54:35–36
Monroe, La., Jan. 22, 1959. Q54:34–35
nr. Ottawa, Kans., Aug. 28, 1960. Q54:372
nr. Traskwood, Ark., Dec. 17, 1960. Q54:372
Rainey, H. E. C. Q54:5
Ratzer, A. F. Q54:135–138
Reactions, Chemical, Controlling. Q54:72–76
Reactive Flammable Liquids, Dry Powder Extinguishing Agents for. Q54:154–157
Recent Navy Research on Dry Chemicals. By Richard L. Tuve. Q54:158–163
Records in Fire Resistive Containers Saved During Fire. Q54:308
Records, Lost in Fire. Q54:297–300, 308, 336, 337
Refinery, Petroleum, Fires
East Chicago, Ind., Mar. 3, 1960. Q54:306
Freeport, Texas, Oct. 24, 1960. Q54:264, 370
Refrigerated Fluids, Cryogenic. Q54:63–70
Relief Valve, Cryogenic Containers. Q54:64
Reports, NFPA Procedures. Q54:47
Research:
Bromotrifluoromethane. Q54:173–177
Carbon Dioxide. Q54:164–172
Dry Chemicals. Q54:151–163
Foam, Fire Fighting. Q54:139–150
Halogenated Extinguishing Agents. Q54:173–177
Nuclear Bomb Fire Effects. Q54:102–113
Sprinkler Spacing. Q54:120–128
Trimethoxyboroxine. Q54:178–181
Rescues Accomplished by:
Cargo Platforms at Piers. Q54:290
Fire Department Ladders. Q54:23, 24, 38, 290
Helicopter. Q54:263
Rescues at Large Loss of Life Dwelling Fires. Q54:237
Residential Occupancies, Sprinkler Performance in. Q54:83
Residential Properties. *See Apartments, Dormitories, Dwellings, Hotels*
Restaurants, Fires Involving:
Albany, N. Y., Sept. 6, 1960. Q54:335
Quebec, P. Q., Oct. 22, 1960. Q54:354
Rocket Experiment Safety. By Atlantic Research Corp. Q54:406–421
Rockets, Fires and Explosions Involving. Q54:253
Roentgen, Measure of Radioactive Fallout. Q54:105
Roof Covering:
Asphalt Used as Vapor Seal, Factor in Fire Spread. Q54:316
Royal Canadian Air Force. Q54:190
Rubbish and Trash:
Fires Caused by. Q54:11, 373
Rum, Destroyed in Fire. Q54:114
Rural Dwelling Fires, Large Loss of Life in, 1959. Q54:10

S

Satisfactory Sprinkler Performance. Q54:81–97
Scaffolding, Handicap in Fire Fighting. Q54:287
School Fire Program, Hamilton, Ont. Q54:78
Schools, Fires Involving. *See also Colleges and Dormitories*
Camden, N. J., Apr. 17, 1960. Q54:313
Eddystone, Pa., Dec. 12, 1960. Q54:344
Empire, Ore., Feb. 17, 1960. Q54:350
Gloucester City, N. J., Mar. 10, 1960. Q54:337
Kenetcook, N. S., Nov. 26, 1960. Q54:309, 330
nr. Memphis, Tenn., Nov. 18, 1960. Q54:359
Wauseon, O., Mar. 19, 1960. Q54:322
West Lanham Hills, Md., Mar. 23, 1960. Q54:57
Winslow, Ariz., Aug. 28, 1960. Q54:358
Winston-Salem, N. C., Dec. 1, 1960. Q54:345
Wrightsville, Ark., Mar. 5, 1959. Q54:38
York Township, Ont., Feb. 16, 1960. Q54:344
Sellors, E. W. Q54:187
Service Stations. *See Stores*
Ships and Barges, Fires Involving:
Brooklyn, N. Y., Dec. 19, 1960. Q54:283–291, 374
Galenia Park, Tex., Nov. 8, 1959. Q54:33, 34
Lake St. Peter, P. Q., Aug. 19, 1960. Q54:373

New York, N. Y., Dec. 19, 1960. Q54:259
Pearl Harbor, Hawaii, June 14, 1960. Q54:373
Ships, Large Loss of Life in, 1959. Q54:33–34, 283–291, 374
Shoe Factory Fire. *See Leather*
Shopping Center Fires. *See Stores*
Shopping Centers, Fire Problems of. Q54:129–134
Shopping Mall, Fire Hazards in. Q54:129–134
Skin Burns, Effects of Thermal Energy from Nuclear Bombs. Q54:110–111
Slate Mine Fire:
Mineral Hills, Mich, June 1, 1959. Q54:42
Smoke:
Factor in Loss of Life in Building. Q54:12, 14, 16–18
Fire Fighting Handicap. Q54:60, 116, 289, 318, 329, 350, 358, 374
Smoke, Effect on Radiation, Nuclear Bomb. Q54:109–110
Smoking in Bed, Fires Caused by. Q54:239, 244
Smoking, Matches, Fires Caused by. Q53:11, 14, 16, 17, 239, 242, 340
Snow, Delayed Fire Dept. Response. Q53:14
Sodium Bicarbonate Dry Chemical. Q54:160–163
Sodium Fires, Use of Dry Powders on. Q54:155
Sodium-Potassium Alloy Fires, Use of Dry Powders on. Q54:155
Solvents, Polar, Foams for. Q54:136, 139
Spacing Automatic Sprinklers. By J. R. Young. Q54:120–128
Sparky, the Fire Dog. Q54:292
Sparky, Use of in Industrial Fire Prevention Program. Q54:55
Special Dry Powder Extinguishing Agents. By Edmund D. Zeratsky. Q54:154–157
Spontaneous Heating, Fires Caused by. Q54:321
Sprinklers:
Complete Protection Effective. Q54:305
Damaged by Explosion. Q54:97, 320, 338
Deluge System Prematurely Shut off. Q54:339
Disconnected in Building Being Razed. Q54:324
Fire Department Connection Not Used During Fire. Q54:330
Fire Department Connection Used but Not Effective. Q54:333
Fire Shielded from. Q54:316, 318, 334, 360
Foam-Water in TCA Hangar. Q54:187–195
Frozen System, Ineffective. Q54:312, 333
Hazard Too Severe. Q54:331
Not a Factor. Q54:316
Overpowered in Exposed Bldg. Q54:316, 340, 360
Partial Protection, Ineffective. Q54:312
Partial Protection, Not a Factor. Q54:330, 332
Satisfactory Performance. Q54:318, 334, 352
Shopping Malls, Need for. Q54:134
Shut Off for Repairs. Q54:331
Shut Off Prematurely During Fire. Q54:330, 339
Spacing of. Q54:120–128
Unsatisfactory Performance. Q54:316, 320, 330, 331, 333, 338
Sprinkler Performance Tables. Q54:81–97
Sprinkler Systems:
Slow or Defective. Q54:97
Testing. Q54:52
Stairways. *See Openings, Vertical*
Standpipes, Hose Burst During Use. Q54:335
Staunton, F. S. Q54:77–80
Steam Generated By Heat of Fire, Fire Fighting Handicap. Q54:287, 288
Steam Line, High Pressure, Cause of Fire. Q53:314
Steel Fabrication Plant Fires. *See Metalworking (Steel Fabrication)*
Steel, Unprotected, Damaged by Fire. Q54:61
Storage:
Foam Liquid Concentrates. Q54:137–138
Improper, Influencing Fire Spread. Q54:305, 318, 319, 320, 348, 349
Storage Occupancies, Sprinkler Performance in. Q54:94–95
Store Fires:
Appliance Sales:
Gary, Ind., Nov. 7, 1960. Q54:349
Clothing:
Harrisburg, Pa., May 27, 1960. Q54:314
Joliette, Que., May 29, 1960. Q54:310
Department Stores:
Harrisonburg, Va., Aug. 31, 1960. Q54:325
Merrill, Wis., July 18, 1960. Q54:265
Windsor, Ont., Oct. 25, 1960. Q54:267, 323
Farm Implements:
Minneapolis, Minn., Mar. 2, 1960. Q54:348
Gasoline Service Station:
Auburn, N. Y., March 30, 1960. Q54:265
Hardware Stores:
San Rafael, Calif., Aug. 26, 1960. Q54:307
Self Service Food Stores:
Toronto, Ont., Nov. 7, 1960. Q54:350
Shopping Centers:
Harwichport, Mass., Dec. 6, 1960. Q54:311
nr. Stockton, Calif., July 8, 1960. Q54:342
Supermarkets:
Boise, Idaho, June 9, 1960. Q54:346
Long Branch, Ont., Mar. 16, 1960. Q54:353
Los Angeles, Calif., Jan. 31, 1960. Q54:342
San Jose, Calif., Mar. 20, 1960. Q54:354
Women's Hats:
Montreal, P. Q., March 2, 1960. Q54:265
Stores, Shopping Centers, Fire Problems of. Q54:129–134
Stoves. *See Heating and Cooking Equipment*
Streets, Closing for Shopping Malls. Q54:133
Structural Defects, Factor Influencing Fire Spread in Large Loss Fires. *See also Specific Defects.* Q54:365
Sulfonation of Benzene. Q54:74
Supermarket Fires. *See Stores*
Supermarkets, Hazards of. Q54:131

T

Tank Cars, Cryogenic Fluids. Q54:66–68
Tanks, Flammable Liquid:
Failed in Fire. Q54:325
Tanks, Foam Liquid Concentrates. Q54:137–138
Tanks, LP-Gas, Failed in Fire. Q54:227
Tank Trucks, Handling Cryogenic Fluids. Q54:63–70
TCA Hangar Foam-Water Deluge Sprinklers. By E. W. Sellors. Q54:187–195
Telephone Out of Order. *See Alarms, Delayed*
Television Support of Fire Prevention Program. Q54:78–79
Testing of Fire-Fighting Foams. By L. E. Rivkind. Q54:139–150
Tests, Carbon Dioxide Extinguishment. Q54:164–172
Tests, Fire, Dry Chemical Extinguishers. Q54:151–153
Tests, Fire-Fighting Foams. Q54:139–150
Tests, Fire, Navy Research on Dry Chemicals. Q54:158–163
Tests, Fire, Nuclear Bomb. Q54:103–113
Tests, Fire, Sprinkler Spacing. Q54:120–128
Textiles, Textile Products Plants, Fires Involving:
Cloth Coating:
Clifton, N. J., Feb. 17, 1960. Q54:282, 330, 360
Hat Factory:
Beacon, N. Y., Sept. 26, 1960. Q54:352
Synthetic Fibers, Part Process:
Paterson, N. J., Feb. 6, 1960. Q54:334
Upholstering Plant:
Guntown, Miss., Dec. 1, 1960. Q54:345

Textile Warehouses. *See Warehouses, Textile*
Thermostat Failure Causes Fire. Q54:340
Thornton, John C. Q54:129–134
Titanium Fires, Use of Dry Powders on. Q54:155
Tobacco, Destroyed in Fire. Q54:114
Torches:
Plumbers, Fires Caused by. Q54:323, 330
Welding and Cutting. *See Welding & Cutting*
Toxicity, Extinguishing Agents. Q54:174–176
Training, Industrial Fire Brigade. Q54:53
Trains, Fires Involving:
Meldrim, Ga., June 28, 1959. Q54:26, 35, 36
Monroe, La., Jan. 22, 1959. Q54:34
Trains, Large Loss of Life in, 1959. Q54:34–36. *See also Railroad Rolling Stock*
Trans Canada Airlines, Hangar of. Q54:187–195
Transportation. *See Aircraft, Railroad Rolling Stock, Trucks, etc.*
Transportation, Cryogenic Fluids. Q54:63–70
Triethyaluminum Fires, Dry Powder Extinguishing Agent. Q54:156–157
Trimethoxyboroxine for Magnesium Fires. By Raymond R. Neill. Q54:178–181
Truck, Industrial, Operation of, Resulted in Fire. Q54:285, 320
Trucks, LP-Gas, Involved in Fire. Q54:227
Trucks, Fires Involving: *See also Automobiles, Buses*
New Brunswick, N. J., Oct. 9, 1959. Q54:30–31
nr. Pottsville, Pa., June 2, 1959. Q54:33
Roseburg, Oreg., Aug. 7, 1959. Q54:33
Tunnels, Fires Involving:
North York Twp., Ont., March 17, 1960. Q54:268
Tuve, Richard L. Q54:158–163

U

Underwriters' Laboratories, Inc. Q54:151–153, 172, 174–177
Unsatisfactory Sprinkler Performance. Q54:81–97
Upholstered Chair, Fires Involving. Q54:14, 16, 18
Uranium Fires, Use of Dry Powders on. Q54:155
U. S. Army Corps of Engineers. Q53:173
U. S. Naval Deperming Station Fire. Q54:422–425
U. S. Naval Research Lab. Q54:158–163, 178–181
U. S. S. Constellation, Fire of Dec. 19, 1960, Brooklyn, N. Y. Q54:283–291

V

Vacant or Idle Property, Fire Involving. Newark, N. J., Apr. 15, 1960. Q54:361
Valve, Relief, Cryogenic Containers. Q54:64
Vehicle Assembly Plant Fire. *See Metalworking*
Venting of Chemical Equipment. Q54:72–76
Viscosity, Foam Measurements. Q54:141–142

W

Walker, Harold S. Q54:422
Wall and Ceiling Concealed Spaces, Nonfirestopped, Factor in Fire Spread. Q54:25, 38, 59, 247, 289, 308, 312, 314, 344, 352
Wall Collapse, During Fire Fighting. Q54:117
Walls:
False Fronts for. Q54:131
Fire Division, Ineffective During Fire. Q54:310
Handicap in Fire Fighting. Q54:354
Lack of, Factor in Fire Spread. Q54:328, 329
Fire Division, Effective During Fire. Q54:310
Unprotected Opening in, Spread Fire. Q54:313
Walls, Windowless, Hazards of. Q54:131
Ward, J. T., Asst. Chief. Q54:283
Warehouses, Fires Involving:
Ammonium Nitrate:
Boron, Calif., May 10, 1960. Q54:321
Auto, Farm, & Road Machinery:
nr. Camden, Ark., Apr. 7, 1960. Q54:351
Chemicals and Drugs:
Boron, Calif., May 10, 1960. Q54:321
Cold Storage:
nr. Nogales, Ariz., Nov. 10, 1960. Q54:306
Cotton:
Henrietta, N. C., Mar. 4, 1960. Q54:320
Electrical Appliances & Supplies:
Oakland, Calif., Oct. 4, 1960. Q54:310
Food Products:
Indio, Calif., Mar. 18, 1960. Q54:319
Maryville, Mo., Dec. 30, 1960. Q54:336
Furniture:
Buffalo, N. Y., Jan. 25, 1960. Q54:311
Liquor:
nr. Owensboro, Ky., June 30, 1960. Q54:319
Machinery:
Lima, Ohio, July 19, 1960. Q54:326
Metal, Metal Products:
Leetsdale, Pa., Apr. 14, 1960. Q54:308
Petroleum. *See Petroleum Bulk Plants*
Plastic Products:
Golden Valley, Minn., Oct. 12, 1960. Q54:348
Textile:
Newark, N. J., Dec. 28, 1960. Q54:350
New York, N. Y., Nov. 18, 1960. Q54:356
War, Fire Effects of Nuclear Bombs. Q54:103–113
Warships. *See Ships*
Watchman Did Not Discover Fire. Q54:369
Watchman Reported Fire. Q54:347
Watchman Service Substandard. Q54:337, 345
Watchmen, Responsibility for Fire Safety. Q54:363
Water Fog, Industrial Fire Dept. Use of. Q54:53
Water Supplies:
Booster Tank Supply on Fire Trucks Only Source. Q54:345, 359
No Public Supply. Q54:345, 359, 360
Private Supply Inadequate. Q54:359
Water to Sprinklers Inadequate or Shut off. Q54:96
Weapons, Nuclear, Fire Effects of. Q54:103–113
Weather, Fire Fighting Handicap. Q54:368. *See also Wind, Snow, etc.*
Welding and Cutting:
Fires Caused by. Q54:268, 324, 328, 343, 360, 374, 422–425
Welding, Permits for, Industrial Plants. Q54:54
What's in a Symbol? Q54:292
Whisky Warehouse Explosion, Glasgow. Q54:114–119
Wind, Effect of Following Nuclear Bomb Attack. Q54:112
Wind, Effect on Fire. Q54:25, 355, 360, 361, 368, 373
Windowless Buildings, Hazards of. Q54:131
Windows, Ordinary Glass, Fire Spread Through Q54:325
Wolfs, Lawrence R. Q54:57–62
Wood Shingle Roof Fires. Q54:309, 340
Woodworking Plant Fires:
Boxes:
Suamico, Wisc., Aug. 19, 1961. Q54:327
Hardwood Turning:
Lowville, N. Y., Oct. 22, 1960. Q54:318
Saw and Planing Mills:
Vancouver, B. C., July 3, 1960. Q54:360
Wood Fiber Plant:
Gatineau, Que., Feb. 20, 1960. Q54:321, 331
Wood Stoves, Fires Caused by. Q54:11–14, 16, 20

Y

Yard Main Shut off During Fire. Q54:334
Young, J. R. Q54:120–128

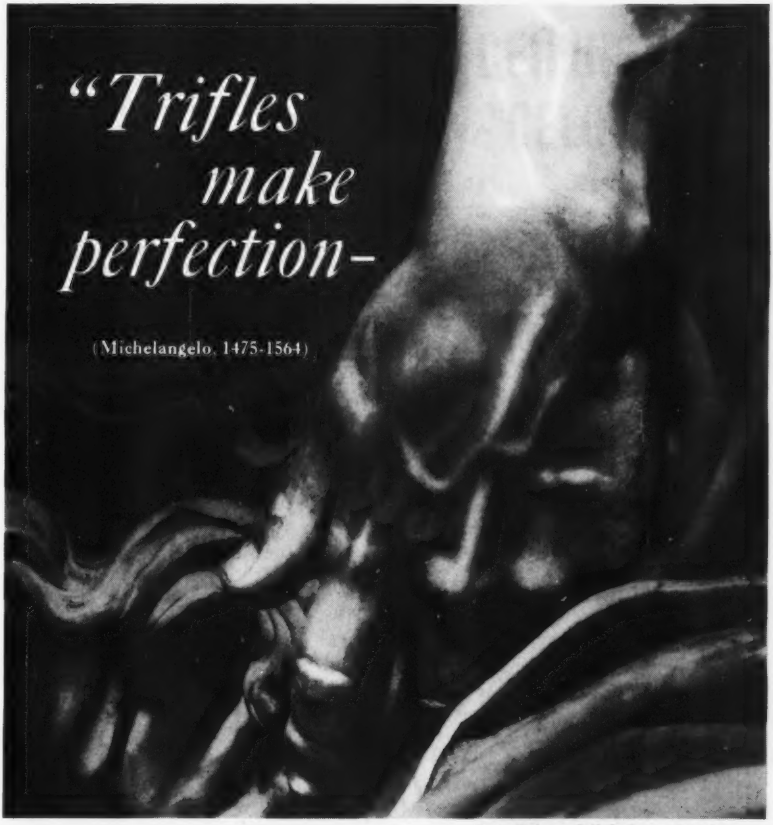
Z

Zeratsky, Edmund D. Q54:154–157
Zirconium Fires, Use of Dry Powders on. Q54:155

INDEX TO ADVERTISERS

April 1961

	Page
American District Telegraph Company (ADT)	A1
American LaFrance, Division of Sterling Precision Corporation	A13
Ansul Chemical Company	A26
Armstrong Cork Company	A30, A31
Autocall Company	A2
"Automatic" Sprinkler Corporation of America	A32
Cardox, Division of Chemetron Corporation	*Inside Front Cover*
Celotex Corporation	A3
Central Station Electrical Protection Association	A12
Central Station Signals, Inc.	A8
Chicago Bridge & Iron Company	A5
Detex Watchclock Corporation	A17
Dusing & Hunt, Inc.	A6
El-Tec, Inc.	A15
Gamewell Company	*Inside Back Cover*
Grinnell Company	*Outside Back Cover*
Kelmore, Inc.	A21
Walter Kidde & Company, Inc.	A7, A16
Kinnear Manufacturing Company	A9
Kuhns Brothers Company	A20
M & H Valve and Fittings Company	A10
R. C. Mahon Company	A25
Minneapolis-Honeywell Regulator Company	A27
National Foam System, Inc.	A11
Notifier Corporation	A28
Raisler Corporation, Raisler Sprinkler Division	A22
Reeve Electrical Company, Inc.	A14
Reliable Automatic Sprinkler Company, Inc.	A29
Rockwood Sprinkler Company	A19
Star Sprinkler Corporation	A24
Tokheim Corporation, General Products Division	A18
Van-Packer, Division of The Flintkote Company	A23
Viking Corporation	A4



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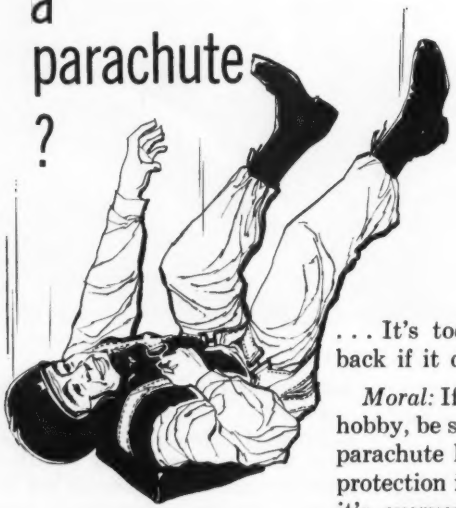

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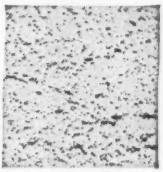

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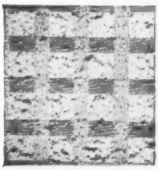

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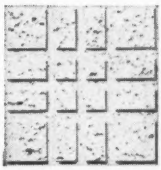

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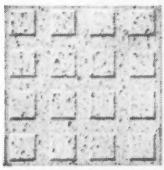

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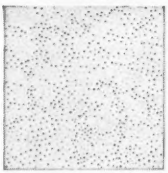

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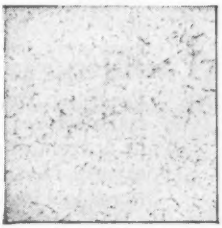
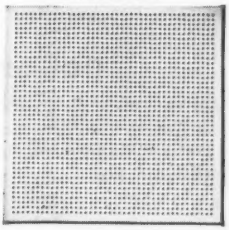


SUPRACOUSTIC®

*TRADE MARK

GYPSUM BOARD ASSEMBLY



CAVITY TILE†

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If it's "by CELOTEX" you get QUALITY . . . *plus!*

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REGISTERED U.S. PAT. OFF.
SOUND CONDITIONING PRODUCTS

Products to Meet Every Building Code • THE CELOTEX CORPORATION • 120 S. LA SALLE ST., CHICAGO 3, ILL.
In Canada: Dominion Sound Equipments, Limited, Montreal, Quebec

Good fire protection is a worthwhile investment at any price. However, it is only good business to get the best equipment at the most realistic cost. This is where Viking can be of great service to you.

VIKING

OFFERS THE BEST IN FIRE PROTECTION

from the ground up

For plant, office or warehouse; an automatic sprinkler system to meet every requirement — Wet, Dry-Pipe, Deluge or Pre-action. Engineered, manufactured and installed by fire protection experts. Pays for itself in reduced insurance costs.

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This colorful elevated steel tank is an excellent combination of plant engineering and sales promotion for Libby, McNeill & Libby. It stores 100,000 gallons of water to instantly supply sprinkler system of Libby's new multi-million dollar plant in Chicago — and provides the plus benefit of product advertising.

Your company, too, can convert a necessity into a promotion piece . . . write today for the new brochure *Tanks that Advertise.*

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Architects and Engineers specified **MAXIMUM**

PROTECTION and UTILITY

FOR THE NEW BUFFALO DUNLOP TIRE WAREHOUSE

with the NEW D-H SLIDING PyroDor®

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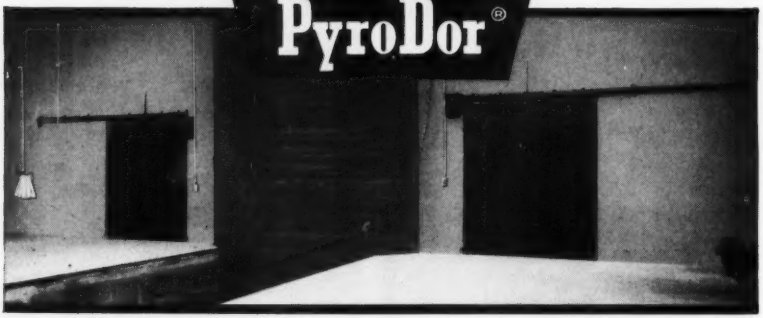

MODERN FLUSH FIRE DOOR DESIGN

COMPLEMENTS STREAMLINE BUILDING

The *ultimate* in safety and protection against fire was the prime factor in the selection of Dusing and Hunt Sliding *PyroDors* . . . for all door openings in fire walls. Here are a few of the many *plus* values whenever D & H Sliding Fire Doors are specified:

LIFETIME GUARANTEE against warping, twisting or shrinking of the **PyroDor** or deterioration of the mineral core caused by rotting or other natural causes.

RUST-RESISTING Heavy gauge steel bonded to core provides "surface-plate" flatness. Armored edges surround entire door.

MODERN HARDWARE Easy operating for large size doors. Fully concealed door hangers and guide rollers protected from damage, dust or dirt.

PYROMATIC AUTOMATIC DOOR CLOSER Only Underwriters' Labeled automatic closing device in sliding fire doors. Permits manual operation at all times . . . yet, fully automatic at controlled speed in the event of a fire.

NEW 8-page Catalog gives complete details, specifications and UL Rating Chart for Class A, B, or C Labels. Write for your copy now. *Consult the Yellow Pages or Sweet's Architectural File for your nearest D & H Distributor.*

D-H DUSING & HUNT, Inc.

67 LAKE ST., N. LE ROY, N. Y.

NEW

HIGHEST-RATED, LOWEST-PRICED ($11.95 RETAIL) 2½ LB. DRY CHEMICAL EXTINGUISHER

14" HIGH

Now — thanks to the new Kidde Kompact — here's high-power fire protection at a rock-bottom price! Highest-rated, lowest-priced 2½ lb. dry chemical extinguisher on the market, the new pressurized Kidde Kompact packs as much fire-killing power as extinguishers costing twice the price. Equal to eight one-quart carbon tet units, the new Kidde Kompact mounts snugly, works simply — just lift the handle and press the lever.

And . . . there's no recharging needed. Just unscrew the used cylinder, replace with another, only $3.95. At the low, low price of just $11.95, no one should be without a Kidde Kompact. U.L. and U.S.C.G.-approved. For more information, see your dealer or write Kidde today!

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Industrial and Marine Division

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Manufacturers of all kinds of approved devices used in Central Station Systems or Class 'A' or Class 'B' Proprietary Fire Alarm Systems, either automatic or manual.

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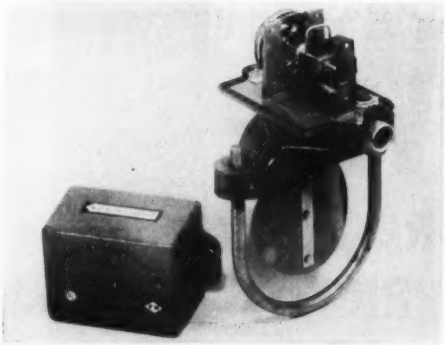


5-inch size shown above. To install simply drill 2-inch hole in pipe.

Model PRS-1

Sprinkler Waterflow Alarm

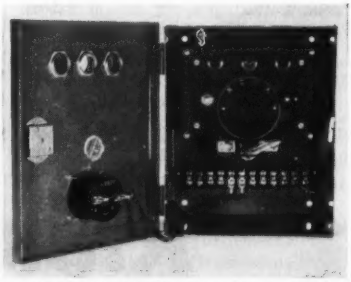
This device is approved by Factory Mutual Laboratories and Underwriters' Laboratories, Inc.

- This device is also made as Model PRT-1, a coded waterflow transmitter.

- Also made in explosion proof models.
- Made in all sizes from 2½" to 8".
- Has instantly recycling pneumatic retarding device, preventing false alarms.
- Has enclosed electrical contacts for any voltage not exceeding 15 amp. 125 volts, A.C. and ½ amp. 125 volts, D.C. Operates on all water pressures or surges.

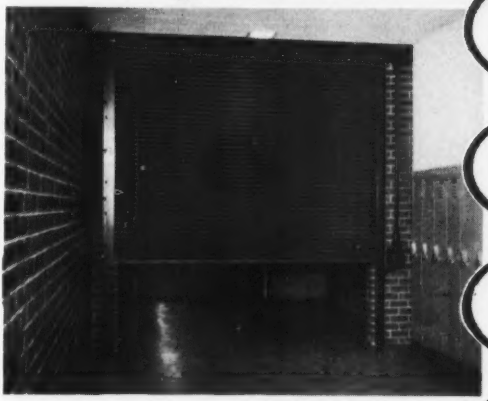
Proprietary & Remote Panels For Fire Headquarters

This Fire Headquarters Unit is designed to be used primarily for the receipt of signals at a remote station when actuated by a local alarm unit in the protected premises. It is electrically supervised and will give a trouble signal in case of open and ground and will also receive an alarm under these conditions. This panel is made for 12 or 24 volt D.C. operation.



Local Non-Coded Fire Headquarters Unit

Check These Features of Kinnear "Akbar" Rolling Fire Doors



- *Automatic release in case of fire.*
- *Positive, spring-activated start.*
- *Operable after automatic closure.*
- *Easily raised and reset after periodic testing.*
- *Curtain can't travel beyond fully closed position.*
- *Also operable for regular daily service.*
- **Labeled by Underwriters' Laboratories, Inc.**

Whether you are considering new fire doors—*or checking existing ones*—make sure they have the features listed at right!

This combination of advantages is available only on modern AKBAR Rolling Fire Doors, made exclusively by Kinnear.

In today's AKBAR doors, *safety features for building occupants* have kept pace with other protective advances.

Fire doors should be checked periodically, to make sure they are in best operating condition. But out-dated fire doors, at best, can give you only part of the protection you may need. Kinnear AKBAR Steel Rolling Fire Doors, available in any size (within U/L limits), are labeled by Underwriters' Laboratories, Inc.

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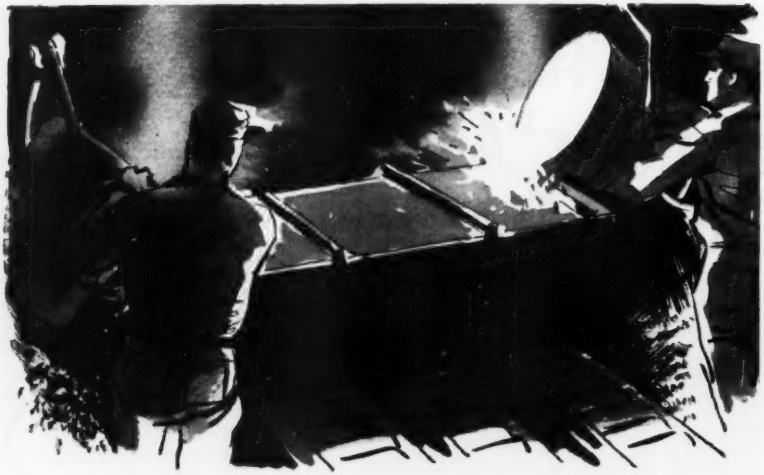
Offices and Agents in All Principal Cities

KINNEAR ROLLING DOORS
Saving Ways in Doorways

Factories: 2250-70 Fields Ave., Columbus 16, Ohio, 1742 Yosemite Ave., San Francisco 24, Calif.



The "3-Ms" in M&H Products

There are 3 Ms in M & H production operations which explains to some extent the wide popularity and increasing sales of M & H valves, hydrants and accessories. The 3 Ms are Men, Machines and Materials. They are the foundation of the superior design, rugged strength and high quality which users of M & H valves and hydrants have so widely recognized.

It requires all three in combination to produce a product which meets M & H standards. M & H foundry raw materials (pig iron, molding sand, everything) and the finished castings (cast iron or bronze) meet latest engineering standards. M & H foundry and machine shop both have efficient, modern equipment. Far more important than either of the foregoing, M & H workmen are craftsmen—skilled in their respective jobs, proud of their work, loyal to their Company and as much interested in making a good valve as is the boss in the office!

So, an M & H customer gets more than just a valve. He gets quality control of materials. He gets improved fabrication by modern machinery. He gets the skillful work of craftsmen who are proud of their job.

These are the 3 Ms which have placed M & H products in the forefront of the American valve and hydrant industry.

M&H VALVE
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From NATIONAL FOAM... Fingertip Information on fire protection for:

FLOATING ROOF TANKS

16-page booklet describes methods of foam application through portable nozzles, portable towers, wind girder flooding systems, roof mounted systems, fixed foam chambers. Additional information on foam dams and foam liquid proportioning. Six engineering diagrams.

MARINE DOCKS

12-page booklet outlines methods of protection with portable extinguishers, fire hydrant systems, water sprinkler systems, carbon dioxide, dry chemical, and foam. Three methods of foam application are described: portable nozzles, monitor nozzles, and fixed outlets. Three full-page diagrams.

LOADING RACKS

16-page booklet outlines types of fires encountered at truck loading racks, and accepted methods of fire protection. These include portable extinguishers, and fixed pipe and portable water spray and foam systems. Three typical diagrams and other illustrations are shown.

National Foam System, Inc., West Chester, Pa.
Please mail the fire protection booklets checked:

☐ Floating Roof Tanks
☐ Marine Docks
☐ Loading Racks

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Company .....
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Sprinkler Valve Alarm — Complete Sprinkler Supervisory — Manual Fire Alarm — Automatic Fire Alarm — Temperature Alarm — Oil Burner Supervision — Burglar Alarm — Hold-Up Alarm — Vault & Safe Protection

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AMERICAN LAFRANCE
The TRUSTED Name
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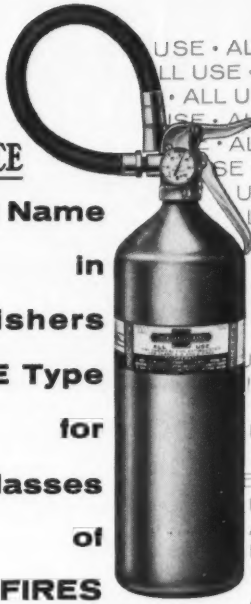
Fire Extinguishers
ONE Type
for
ALL Classes
of
FIRES



AMERICAN LAFRANCE announces the NEW "ALL-USE" Fire Extinguisher to handle A, B or C fires quickly, effectively. Engineered to the high quality standards of American LaFrance, and subjected to rigid laboratory and field tests, the "ALL-USE" eliminates the fire emergency confusion and delay in finding the right type of extinguisher for the fire. Easy to use, pull pin, squeeze handle . . . Non-toxic, non-corrosive, non-freezing. Available in 10 and 20 lb. sizes. *(The American LaFrance ALL-USE 10 lb. is the only 10 lb. extinguisher approved for A, B or C fires. Its rating is equal to most competitive 15 lb. extinguishers.)*

For further information or a demonstration in your plant or a complete survey of your fire protection needs, phone, wire or write:
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Underwriters' Laboratories
Ratings 10 lb. 1A:16B:C
20 lb. 3A:20B:C
Factory Mutuals
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No. 162.010/181/0
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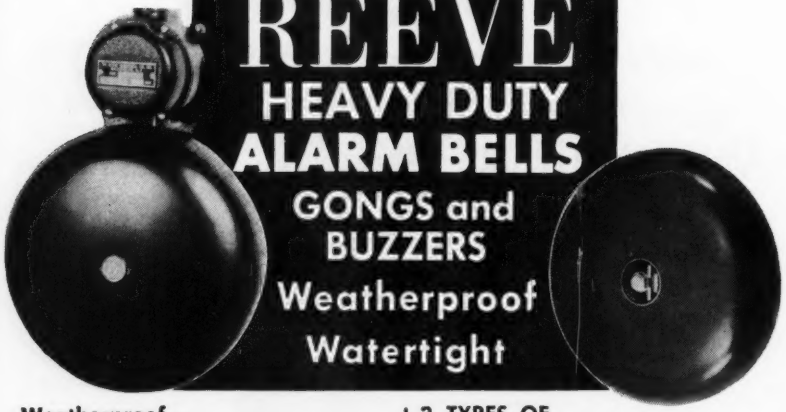

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HEAVY DUTY ALARM BELLS
GONGS and BUZZERS
Weatherproof Watertight

Weatherproof —
Sizes 3", 4", 6", 8", 10", 12"
DC—6—220 V. · AC—12—220 V.

Watertight —
Sizes 3", 4", 6", 8", 10", 12"
DC—6—220 Volt · AC—12—220 Volt
60 Cycles, 110—220 Volt, 25 Cycles

3 TYPES OF
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OPEN PIGTAIL·WEATHERPROOF·E-Z MOUNT
Sizes 6", 8", 10". Cast aluminum housing
Hot Pressed Steel Gong Shell
Single Stroke and Vibrating Types
Voltages are the same as Neck Type

Special Windings on request.

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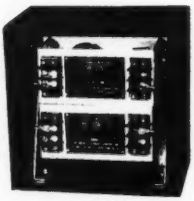
The unit is designed for use on any storage batteries not subject to heavy drains. It will trickle charge the battery indefinitely because of its automatically decreasing rate of charge.

For use with six cells (12 volts). Automatically controlled by saturable reactor. Continuous output one ampere. 22.5 watts, 118 volts, 60 cycles. 3% Regulation. 9" x 9" x 6" — 14 B & S gauge steel wall cabinet. 15¼ lbs. U.L. Approved. No moving parts.



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CENTRAL OFFICE and LOCAL FIRE ALARM DEVICES
• automatic alarm devices • sprinkler alarm and supervisory devices • burglar alarm devices and accessories. DYNALARM (sound detection for both reverberant and non-reverberant vaults).

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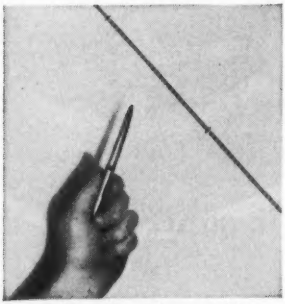
SEE FOR YOURSELF! Write today and we'll arrange an actual demonstration in your city at your convenience. Now you can give your city a safe and efficient emergency traffic control.

FOR LOW-COST, DEPENDABLE FIRE DETECTION-ALARM!



Kidde Atmo fire detector tubing.

KIDDE ATMO: Ideal for schools, hospitals, plants, public buildings, Kidde Atmo Fire Detecting and Alarm Systems use highly sensitive rate-of-temperature-rise detection tubing. Easy to install, simple to maintain, Atmo systems give fast warning in first stages of fire.

Kidde Fyrindex detection elements.

KIDDE FYRINDEX: Now — dependable fire detection at the lowest possible cost. Kidde Fyrindex features fast-acting, self-resetting detectors, comes in either rate-of-rise, fixed temperature or combination models.

Both Kidde systems are U.L. and F.M. approved; sound alarms locally, at central station, or at municipal fire headquarters; feature one to one hundred zone control and annunciator panels.

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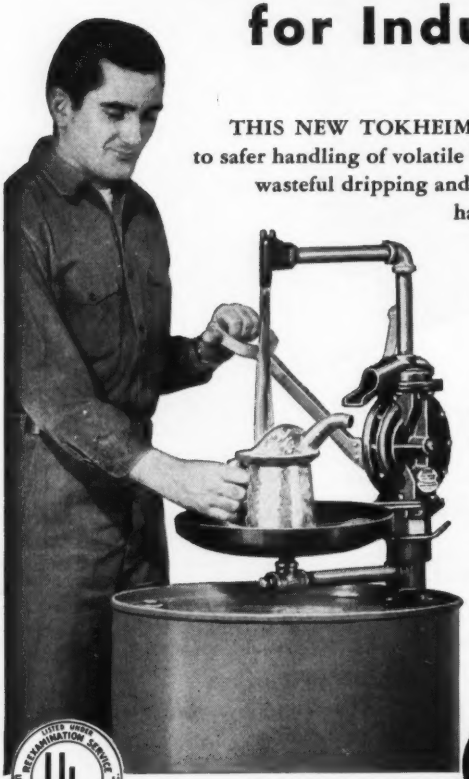

THIS NEW TOKHEIM HAND PUMP contributes to safer handling of volatile liquids wherever used. Stops wasteful dripping and slippery floors. Reduces fire hazard and accidents common to other methods of liquid transfer. Approved for handling petroleum liquids —ideal for many others. Available in 22 different models for 'most any use— from pipe lines to drums, or underground tanks, with hose or spout outlets. Order from your dealer, your oil company, or your Tokheim representative.

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When life is measured in minutes

It only takes a minute — for dense clouds to billow from windows . . . winds to whip flames into a roaring inferno . . . and tragedy to strike — *all needlessly!* For in those same minutes a Rockwood Sprinkler System can give you priceless protection from the fire.

By actual records of the National Fire Protection Association there has never been a loss of life in a completely sprinklered school. Sprinkler systems have been effective either in completely extinguishing the fire or holding it in check. These are facts.

And facts are what insurance companies base their rates upon — that's why *you can save up to 80% on your fire insurance policy when your property is protected by sprinklers.* And remember, you can have a system installed on a deferred payment plan. Your insurance savings can pay a substantial part of the cost of the system.

The Rockwood Sprinkler Company has a staff of scientifically trained fire-fighting experts that will be happy to meet you or your committee to give full information and advice on how an engineered sprinkler system can save lives and property. Call the Rockwood fire engineer nearest you.

ROCKWOOD SPRINKLER COMPANY

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Engineers Water . . . to Cut Fire Losses

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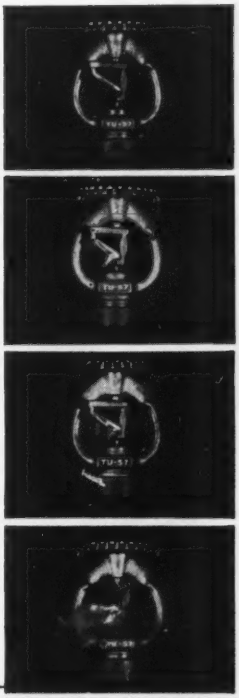

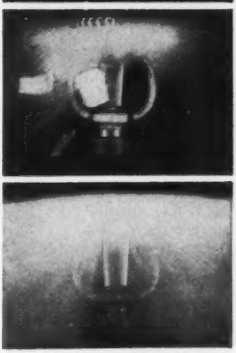

One-tenth of a second after the solder melts on this Rockwood Sprinkler head, water sprays out to extinguish or control the fire — *all automatically!*

NOW... Kuhns ductile iron fittings

For Sprinkler Systems

Kuhns ductile iron pipe fittings—the newest development in piping—provide an extra margin of operating safety for sprinklers, high pressure lines and other vital piping systems. High structural strength and resistance to thermal shock help these fittings prevent leakage caused by vibration, temperature changes or misalignment.

"K" Pipe Lock Couplings

Listed for 800 psi by Underwriters' Laboratories, Inc., these couplings have a safety factor of five times the UL listing for 2½" through 6" and four times UL listing for 8". Sizes: 2½" through 8". Look for the "800 D" on each.

"K" Flanges and Flanged Fittings

Pressure rating, 500 psi by Underwriters' Laboratories, Inc. for elbows, base elbows, 45° elbows, side outlet elbows, tees, side outlet tees, and reducers in straight and reducing sizes. Flat faced flanges standard. Extra heavy flange dimensions and raised faces available. Look for the "DI 500" on each.

Complete range of sizes through 12".

"K" Screwed Fittings *

Pressure ratings listed by Underwriters' Laboratories, Inc.

STEAM AND OIL AT 550°F

¼" to 3".....300 lbs.

LIQUID AND GAS AT 150°F

¼" to 1".....2000 lbs.

1¼" to 2".....1500 lbs.

2½" to 3".....1000 lbs.

**Ductile iron fittings are available in any size in Kuhns complete cast iron line, ¼" through 12".*

Note: These fittings are excellent for liquefied petroleum gas systems. Look for the "DI 300" on each.

Send for our catalog or contact your wholesaler.

THE KUHNS BROTHERS CO.

1800 McCALL STREET, DAYTON, OHIO

AN ACCIDENT.....

This particular one occurred in the University of Iowa Chemistry Building on 5/4/59. The "kitchen type" refrigerator shown had been filled with chemicals and stored solutions. Only the shell remained after the explosion and resultant fire.

A number of these accidents occur yearly in laboratories and industrial plants all over America because a kitchen type refrigerator is used where an Explosion Proof refrigerator should be mandatory.

EXCERPT FROM NFPA "LABORATORIES" FIRE RECORD:

"This type of explosion will become ancient history when explosion proof refrigerators are used exclusively by industry." FR-58-3

THE ANSWER...

KELMORE EXPLOSION PROOF REFRIGERATORS ... used right now by General Motors and General Electric, two of the world's largest manufacturers of kitchen type units. KELMORE can't ignite, won't explode. They're UL approved for hazardous locations Class C&D ... will give you years of trouble free service. Economical, too. Send for complete catalogue. It's yours free.

MANUFACTURED BY

KELMORE, INC.

599 SPRINGFIELD AVENUE
NEWARK 3, NEW JERSEY

The
"MINUTE MEN"
of FIRE PROTECTION

PENDANT
MODEL SSP

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GRIMES SPRINKLERS stand guard over your life and property 24 hours of every day, year after year after year. It is comforting to know they are always dependable and ready to go into action at a minute's notice! Because GRIMES Fire Sprinkler Systems and Equipment are engineered for better protection.

Through the years, GRIMES has earned a reputation for designing, developing and manufacturing the newest and most improved sprinkler equipment available.

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Flintkote • Van-Packer Model HT Smokestack is UL-listed . . . ideal for incinerators & boilers

Wherever you see a Flintkote • Van-Packer Model HT Smokestack specified for incinerators, boilers or furnaces, you can be sure it will provide safe, reliable service. It is listed under the Factory Inspection and Label Service Program of Underwriters' Laboratories, Inc.

Van-Packer Smokestacks are erected from factory-built, insulating refractory sections. Each 3-foot section is encased in a corrosion-resistant metal outer jacket. Joints are sealed with acid-proof cement and secured with corrosion-resistant draw-up type joint bands assuring utmost strength and safety.

Model HT Smokestacks safely handle industrial incinerator flue gas temperatures up to 1800°F and up to 2000°F for occasional brief periods of forced firing. They won't corrode and average three times greater life than steel stacks. Insulating qualities of refractory wall prevent heat loss, give draft equal to brick and greater than steel.

Write for data file giving full information on Flintkote • Van-Packer Smokestacks

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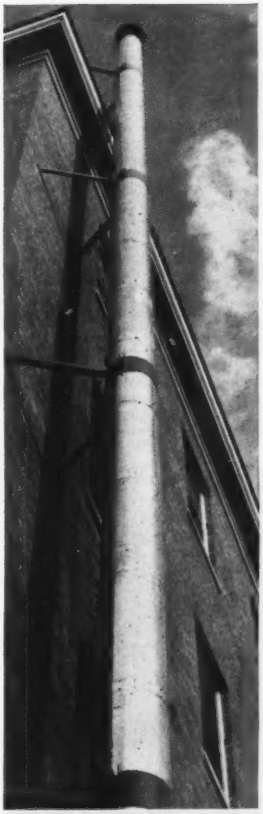

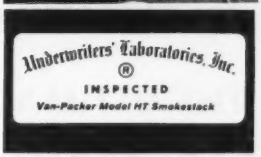

In the West: *Pioneer Division, The Flintkote Company, Box 2218, Terminal Annex, Los Angeles, Calif.*

In Toronto, Ontario: *The Flintkote Company of Canada, Ltd.*

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Ceiling Pattern (Flush-Type) Automatic Sprinklers

☆ **DECORATIVE**

☆ **DISTINCTIVE**

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STAR SPRINKLER CORPORATION

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ROLLING-STEEL FIRE DOORS

PREFERRED FOR USABILITY . . . SPECIFIED FOR PROTECTION

ABOVE: A Mahon Rolling Steel Fire Door Serves a dual purpose—an internal dividing wall and an automatic fire barrier. BELOW: Window shutters too, are Mahon—supplied in sizes to your need for full fire protection.

Automatic Fire Doors and Shutters from Mahon have been carefully engineered to offer you many advantages of safety and function. They are operated manually or mechanically in everyday use—automatically closing if fire breaks out. This quick action cuts off drafts, confines the blaze and reduces losses. No other type of fire door provides all of these important features: Underwriters' Label; vertical roll-up action, minimum space demands; all-metal construction; Bonderite-protected plus rust-inhibiting synthetic baked enamel; and quality built for long life. You will find a Mahon Automatic Fire Door or Shutter to suit your use . . . your property . . . your protection.

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carbon dioxide and water extinguishers...
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...and automatic systems.

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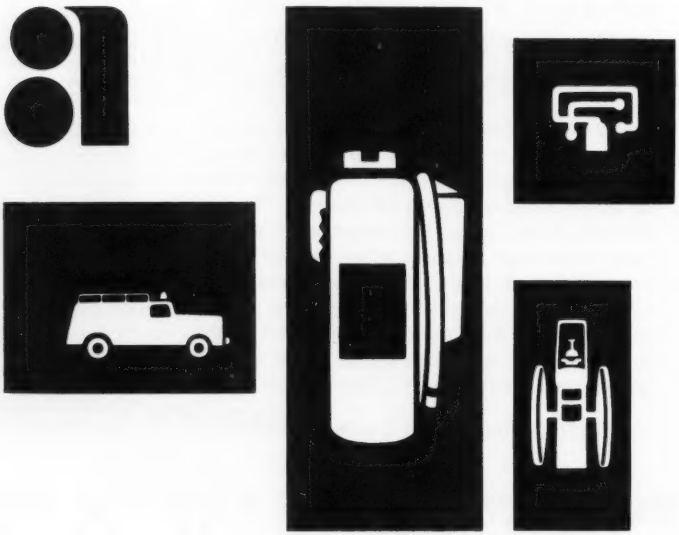

New Honeywell Smoke Sentry "sees" the first sign of a fire—assuring the best possible protection of lives and property!

No one knows better than you that when fire strikes, there is no time to spare for human error! In minutes, a spark can grow into a blazing inferno. Before that, smoke can make the atmosphere deadly.

Now Honeywell has developed a smoke detection system that *sees* the first sign of fire — smoke — first. The new Honeywell Smoke Sentry employs the principle which provides the fastest means of smoke detection. It stands guard over large, open areas with a constant beam of light. When smoke interrupts this beam, an alarm sounds instantly. The smoke sensitivity of the devices can be regulated to operate even for the tiniest wisp of smoke and trigger the alarm. And an annunciator panel can be used to pinpoint the area of the building in which the fire has started.

The new Honeywell Smoke Sentry is designed to be used with Honeywell's Fire Detection and Alarm System in schools, hospitals, nursing homes, dormitories, hotels — wherever fast automatic detection is critical. For complete information, call your local Honeywell office. Or write Honeywell, Dept. QN-4-92, Minneapolis 8, Minnesota. *Sales and service offices in all principal cities of the world.*

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a complete line of

Console and cabinet equipment

Automatic Thermostats and Manual Stations

DETECTION and NOTIFICATION devices

CONTROL equipment

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including Notifier's new

N-CO-BELL®

in all standard voltages, created with imagination, not imitation

N-CO-BELL's controlled stroke provides superior gong vibration producing a distinctive and arresting sound. Low amperage drain allows more bells per circuit.

and now, another first from Notifier!

NEW PLUG-IN UNITS (with 5 year Guarantee)

Eliminate tampering by untrained personnel with NOTIFIER'S *plug-in units*—the first in the field.
Remember—NOTIFIER has the most complete line of fire detection and notification devices, control equipment and alarm devices. They can develop a system for you regardless of the size or location of your operation.

NOTIFIER CORPORATION also manufactures

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- Proprietary Systems
- Auxiliary Control Relay Equipment
- Tripping Devices
- Annunciators
- Special Power Supplies
- Gate Valve Switches
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- Pressure Switches
- Local Water Flow Alarm
- Signaling Units
- Thermostats
- Security Patrol Stations
- Manual Break Stations
- Coding Devices
- Bells (1,664 Models)
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Attention qualified people: NOTIFIER CORPORATION is a fast growing concern. There's a bright future for you in selling, installing and servicing NOTIFIER systems. NOTIFIER also needs qualified engineers to work with architects and specifying engineers. If you're interested and feel you can qualify, write to

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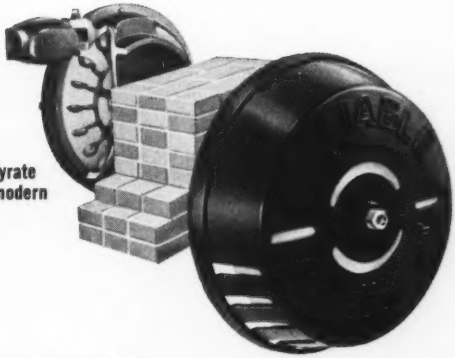
NOTIFIER FIRE ALARM

ONLY RASCO OFFERS THE MODERN LOOK IN AUTOMATIC SPRINKLER ALARMS!



NEW!
Exclusive—Attractive Gong Cover of tough Butyrate Plastic, blends with all modern building architecture.

NEW!
Exclusive—Rugged Aluminum Gong.

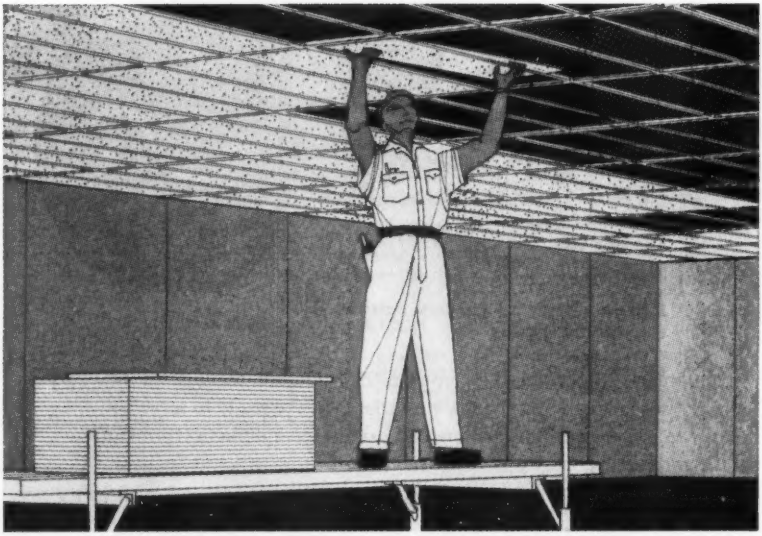
NEW!
Exclusive—Plastic and Aluminum materials eliminate rust-streaking.

Reliable Licensees are conveniently located throughout the United States and foreign countries. They're ready to serve you in the design, installation and service of automatic sprinkler protection.

Look to Rasco for Complete Fire Control!

THE RELIABLE AUTOMATIC SPRINKLER CO. INC.

Armstrong's new lay-in structural components from three hours to



Large 24" x 48" lay-in units are installed in record time. Since there's no waiting for wet work to dry, these lay-in units are ideal for both new construction and remodeling jobs.

ceiling system protects flame and intense heat for earn U.L. rating

The new Armstrong Acoustical Fire Guard lay-in ceiling combines the advantages of an exposed grid system—economy and fast installation—with the protection offered by a time-design-rated acoustical ceiling.

Here's how the lay-in units work with the specially designed Fire Guard Grid Suspension System* to protect the structural components of a building.

Due to its composition, the lay-in unit can withstand exposure to flames and 2,000-degree heat. The new grid system, designed to support these units, will withstand this same intense heat by allowing its members to expand without buckling. The lay-in units stay firmly in place.

The Fire Guard lay-in ceiling system has been given a three-hour beam protection rating by Underwriters' Laboratories, Inc. Assemblies using bar joist and slab as well as beam and steel floor construction earned two-hour ratings. Acoustical Fire Guard tile, with U.L. ratings of up to *four hours,* can be used in areas that require even more protection.

The Acoustical Fire Guard lay-in ceiling is available in both the popular Classic and Fissured designs. There are two nominal sizes: 24″ x 24″ x ⅝″ and 24″ x 48″ x ⅝″.

For more information about either Acoustical Fire Guard tile or lay-in units, call your Armstrong Acoustical Contractor (he's in the Yellow Pages under "Acoustical Ceilings") or your nearest Armstrong District Office. Or write to Armstrong Cork Company, 4204 Woodbridge Street, Lancaster, Pennsylvania.

* Patent Pending

Armstrong ACOUSTICAL CEILINGS

First in Fire-Retardant Acoustical Ceilings

For your EXCEPTIONAL HAZARD OCCUPANCY

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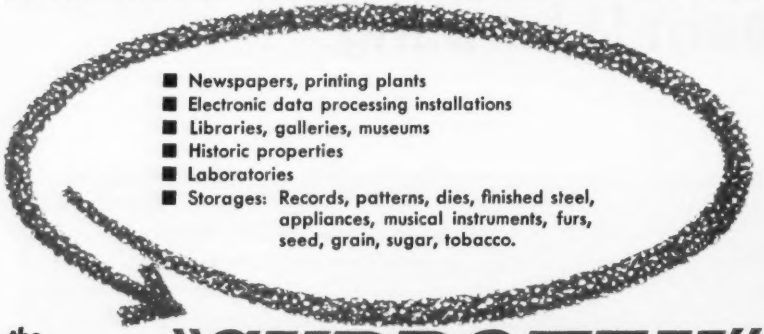
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RATE-OF-RISE SUPERVISED PRE-ACTION SPRINKLER SYSTEM

Water WHEN you need it . . . and ONLY where you *need* it!

Fire is a far worse enemy than Water—in *any occupancy*. There's no protection like sprinkler protection . . . for *exceptional hazard* occupancies, no system like SUPROTEX — to fight fire, limit water damage: **• Fast detection • Pre-Alarm gives time for first aid before sprinkler opens • No leakage from damage to sprinklers, piping • No freeze-ups • Independent detection—stands guard during system alterations • Completely supervised.**

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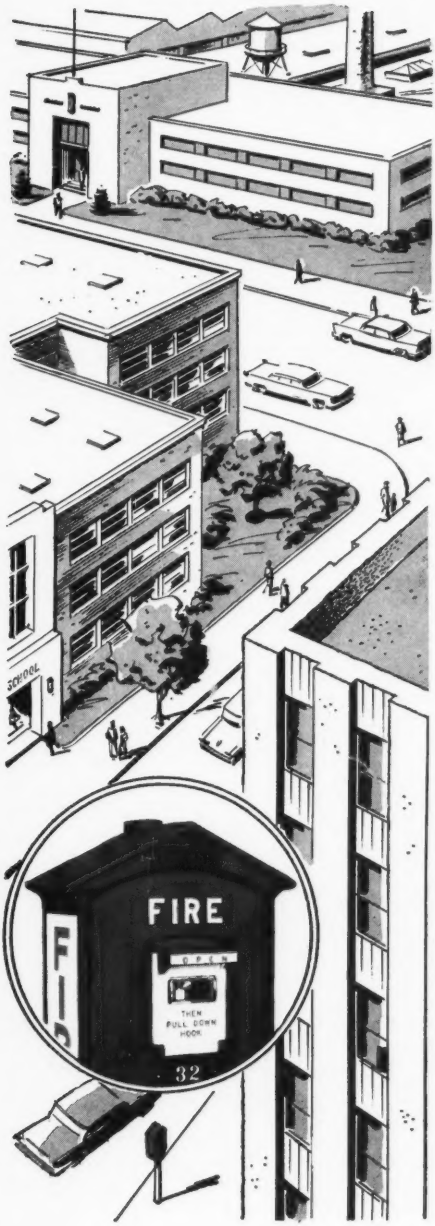

Put PROVED dependability into interior FIRE ALARM systems!

You can provide today's *best* fire alarm protection for any industrial, commercial, or institutional building with a Gamewell FLEXALARM System. Thoroughly pre-engineered by the fire-protection professionals who developed the familiar "pull" fire alarm box, it assures the same unmatched efficiency and dependability *inside* buildings.

Precisely tailored to each installation, FLEXALARM is available as a coded or non-coded system, semi or completely automatic, with practically limitless possible combinations of annunciators, special drill, test, and alarm features. For example, it can be tied into the municipal alarm system at the curb; integrated with the sprinkler system; or automatic fire detection devices.

FLEXALARM is designed for unit-by-unit expansion depending on specific life hazards, fire defense plans and the growth of your plant. It's simple to specify, easy to install, efficient and economical. Gamewell will be happy to assist with fire detection engineering of new construction, expansion, or modernization, if desired. It's a service that gives you the benefit of over 100 years' experience with fire protection systems. Specify Gamewell . . . single source for engineering assistance and complete product line . . . maximum protection at minimum cost. Write THE GAMEWELL COMPANY, 1335 Chestnut St., Newton Upper Falls 64, Mass.

Gamewell

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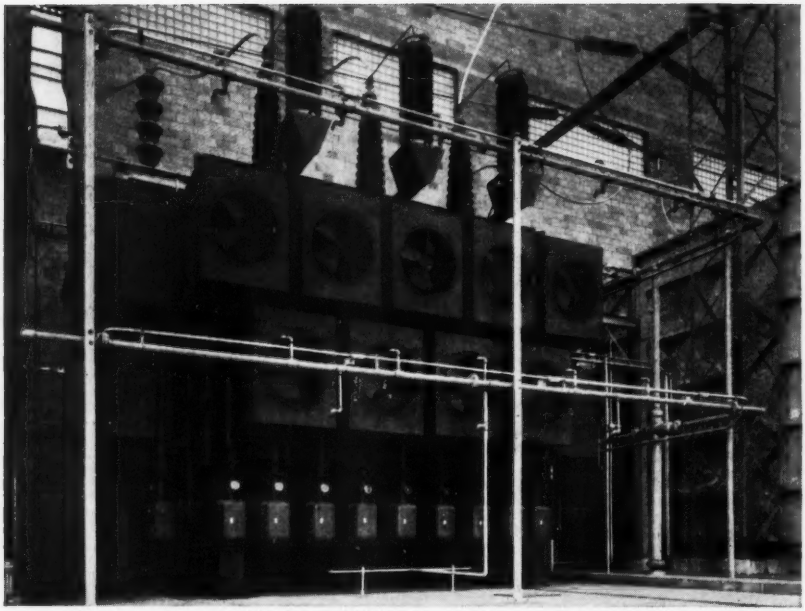

Transformer protected by Grinnell Water Spray System at 450,000 KW Unit No. 5 of American Electric Power Company's Phillip Sporn Station at New Haven, West Virginia.

Grinnell fire protection systems guard one of America's largest power stations against shut-down by fire!

Grinnell Water Spray systems protect two main transformers, two auxiliary transformers, the reserve auxiliary start-up transformer, the vital sections of the coal conveyor system, cable trays, auxiliary boiler feed pump oil tank, and the stator and seal oil unit at Phillip Sporn Station. Grinnell Foam-Water system protects the basement floor area in the vicinity of the turbine pedestals.

Grinnell-installed Carbon Dioxide systems protect the main boiler feed pump oil tank and the turbine oil and lube oil tank rooms. Grinnell-installed Dry Chemical systems protect the main turbine bearings, the stop and intercept valves, and the pedestal cavity behind the front standard.

Remember, whatever your fire protection needs, there's a Grinnell system just right for you. Send for the reprinted article, "How Good Is Your Fire Protection?", which details fire protection for generating stations.

Write to Grinnell Company, Providence 1, Rhode Island.

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